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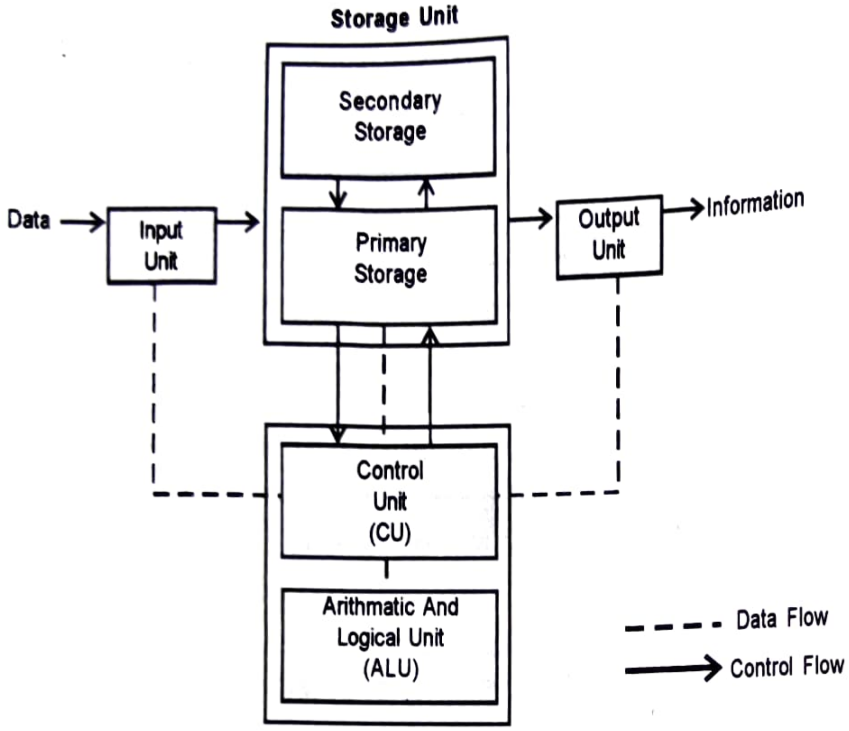
1.1.1 Block Diagram of Computer


Storage Unit
Secondary Storage
Primary Storage
Data
Input Unit
Output Unit
Information
Control Unit (CU)
Arithmatic And Logical Unit (ALU)
Data Flow
Control Flow

Central Processing Unit (CPU)

The basic components & parts of computer system are given below:

- Input Unit
- Output Unit
- CPU (Central Processing Unit)
- Storage Unit
- ALU (Arithmetic Logic Unit)
- Control Unit

✓ Input Units

The set of instruction or information is provided to the computer system or PC with the help of input devices such as (keyboard, mouse, scanners etc). The instruction or data presented to computer system is converted into binary form then it is supplied to computer system for further processing.

The Input Unit perform transferring the data from outside the world into the system and later this data is processed, and system produces instruction through output unit such as Printer, monitors etc.

The Input devices enters the data from outside the world into the primary storage devices.The input devices are a means of communication with outside world and our computer system.

- Input Devices accepts or receives the data or instruction from outside the world such as input devices like keyboard and mouse
- It converts the data or instruction or information into machine readable form for further processing.

- Later it supplies the decipherable information to PC for additionally handling
- They act like a connection between outside the world and our own computer system
- Keyboard and mouse are the prime examples of input devices.
- When the procedure is finished we get or receive desire result using output devices such as printer's and monitor's.

✓ Output Units

Output devices of computer produce or generate results with the help of devices or gadgets such as printer,monitor etc. Primarily these instruction or data provided to computer system is in binary code so to produce or generate the desired output the system must convert this data into human-readable form, to do so it has to first present the data or instruction to computer system for further processing or handling.With the help and assistance of output devices, the system is linked or connected with outside world.

For Example, the data or instruction such as Graphics, images or text is inserted in the computer system with the help of input devices as the data received from the input devices is in binary code, therefore, the data has to be primarily converted into human readable form after processing user get the required or desired data or set of information.

The prime examples of Output devices are Printer, Monitor,Projectors etc

- The output devices receive all the data or instruction in binary code.
- The output devices convert the binary codes into human readable or intelligible form for better understanding and better functionality.
- They produce the changed or converted result to the user. which is effectively comprehensible by humans for proper and accurate understanding.
- They act as a connection or link between outside world and computer system or our own PC framework.
- Printers, monitors and projector's are the prime examples of output devices.

✓ Central Processing Unit (CPU) of Computer System

The Central Processing unit is also called as brain or heart of a computer.The CPU is nothing but an electronic hardware device which carries or performs out all the operation such as arithmetic and logic operation.

The CPU in another term is also called as "PROCESSOR".Every instruction given through the input devices such as keyboard or mouse is carried further for processing and we user get our desired results through are output devices.

The CPU is also responsible for controlling all the operations of the other units of the computer system.

✓ Control Unit

The control Unit or CU Controls or coordinates all activities performed in a computer system. It receives information or instruction or directions from the main memory of computer.It tells the logic unit, memory as well as the input and output devices how to handle the program or instruction in proper order.When the control unit receives any set of information or instruction it converts them to control signals then this signals are sent to the central processor for further processing and finally, it understands which operation to execute, exactly or precisely and in which order.

✓ Arithmetic and Logic Unit

An **arithmetic logic unit (ALU)** is a digital circuit used to perform arithmetic and logic operations. It represents the fundamental building block of the central processing unit (CPU) of a computer. Modern CPUs contain very powerful and complex ALUs. In addition to ALUs, modern CPUs contain a control unit (CU).

Most of the operations of a CPU are performed by one or more ALUs, which load data from input registers. A **register** is a small amount of storage available as part of a CPU. The control unit tells the ALU what operation to perform on that data, and the ALU stores the result in an output register. The control unit moves the data between these registers, the ALU, and memory.

ALU performs arithmetic and logical operation.When a set of instruction or program is conveyed out, control unit generally characterized which sort of operation to execute.Arithmetic operation comprises of (Addition, subtraction, division, multiplication) and the logical unit carries out the operation such (AND, OR, Equal, less than, greater then)) and later the control is changed to ALU and the result generated in ALU later stored or puts away in transitory memory.

✓ Storage Unit of Computer

The information or set of guidelines can be stored in PC storage unit when information or direction is exhibited to the PC system utilizing Input devices.To begin the procedure on information, Instructions given by input devices the information must be put away in memory, and later when the preparing is done the outcome produced is likewise put away in computer system for additionally handling.

This type of work and action is done by storage unit. In another word, we can also describe the storage unit as the unit which gives space to store data or instruction of processed data, processed result.

- It stores information or instruction
- It stores results
- It stores consequence of prepared data

Storage Devices: The term storage is defined as the devices which stores data given by the input devices or output devices after processing,the data is stored in computer system i.e Primary storage or secondary storage depends entirely on the size of data.

There are mainly two types of storage Unit

- Primary Storage
- Secondary Storage

Primary Storage : They are also called as Main memory or in other words as RAM (Random Access Memory).The Data or set of instruction is stored in primary storage before processing and later the data is transferred to ALU where further processing is done.

The primary Storage cannot store huge amount of data, and the data store in this memory is temporary (The data is lost when there is power failure), it is also called as temporary memory. Primary storage has limited storage capacity because it is very expensive and generally made up of semiconductor devices.

The example of primary Storage is L1 Cache of Processor

Secondary Storage: Secondary storage are also called as permanent storage unit as when the data store in this memory are stored permanently user can recall the data whenever they need. The data remains in this memory even when there is a power failure or shutdown, they are much cheaper then primary memory.

The Example of Secondary Storage are Hard disk and Zip drives

1.2 CHARACTERISTICS OF COMPUTER

✓ Speed

Computers have an incredible speed with accuracy that is beyond human capabilities, not only they have speed but the speed with accuracy and Pinpoint solutions to every problem arises before them.

The speed of computer is considered as one of the most important characteristics of computer. As per human beings, the smallest unit of time is considered to be second, but not for computers seconds are further divided into milliseconds, microseconds, nanoseconds and picoseconds. The powerful PC can work almost 5 million instruction per seconds. When we discuss the speed of computer milliseconds are hundredth of a second, microseconds are the millionth of a second, nanoseconds are the billionth of a second and picoseconds are trillionth of a second.

Speed is primarily the main characteristic of computer, their speed is measured in terms of Gigahertz and Megahertz. They can solve complex to complex numerical and logical problems with ease compared to human beings.

✓ Accuracy

They have a great speed and are unbelievably deadly accurate. The Errors occurs due to improper or wrong or inaccurate input given to the computer system. PC primarily depends upon the inputs. Say if a user enters wrong or improper or inaccurate information to the computer obviously the output generated by them will be wrong, improper or inaccurate.

The Errors we received while using personal computer are generally called as "Human Errors" or the errors of programmers who writes program for better computer functions. GIGO (Garbage In Garbage Out) is a well-known term used for computer accuracy, if the input is wrong the output will also be wrong

✓ Memory

This is also one of the most essential characteristics of computer these days they can store or save almost any volume of data due to its high storage capabilities. Once the data or instruction saved to the computer memory it remains in the memory, until and unless someone deletes, users can recall or retrieve the data anytime, at any location they require, As the human being tends to forget small information given to them, but these machines stores all the information was given to them permanently.

These Machines can store the data as long as user's desire. The measurements of memory are Megabytes (MB), Gigabytes (GB) And Terabytes (TB).Hard disk and pen drives are examples of memory.

✓ Diligence

They can work long hours without tiredness or boredom with same speed and accuracy.As the computer is a machine its does not refuse to work and works for hours and hours with the same consistency. But on the other hand human being can get easily tired of same work repeatedly can lose their concentration, speed, and accuracy because human suffer from tiredness, laziness, unlike machines.

✓ Versatility

They can perform several tasks at the same time, such as user can play songs, work on documents, search for any documents in the hard disk, surf the net, download software, calculate, a computer can perform several functions at the same time with same speed, accuracy and with consistency. Unlike human computers are far more versatile.Therefore computers have reached to all essentials part of the human society.

✓ Reliability

They are reliable machines, because of their reliability many organizations, institutions, companies rely on them hugely. They can store huge amount of data and can be recalled or retrieve quickly any time or any place as the user demands. The errors occur in the computer are all human errors.Once given a huge task or operation they complete the work without any excuses and people or users can rely on them.

✓ Low Cost & Reduced Size

The advancement in the development of computer hardware and software technology the cost of PC has been decreased drastically and has reached to the majority of the humans.Due to its low-cost hospitals, institutions, government sectors, companies, and end users have welcomed them with open hands.

✓ Automatic

They can perform Automatically when assigned a task or operation say you have started a download of movies the computer will download the entire movie in spite the user is present or not without any interruption unless there are network errors or connectivity issues.

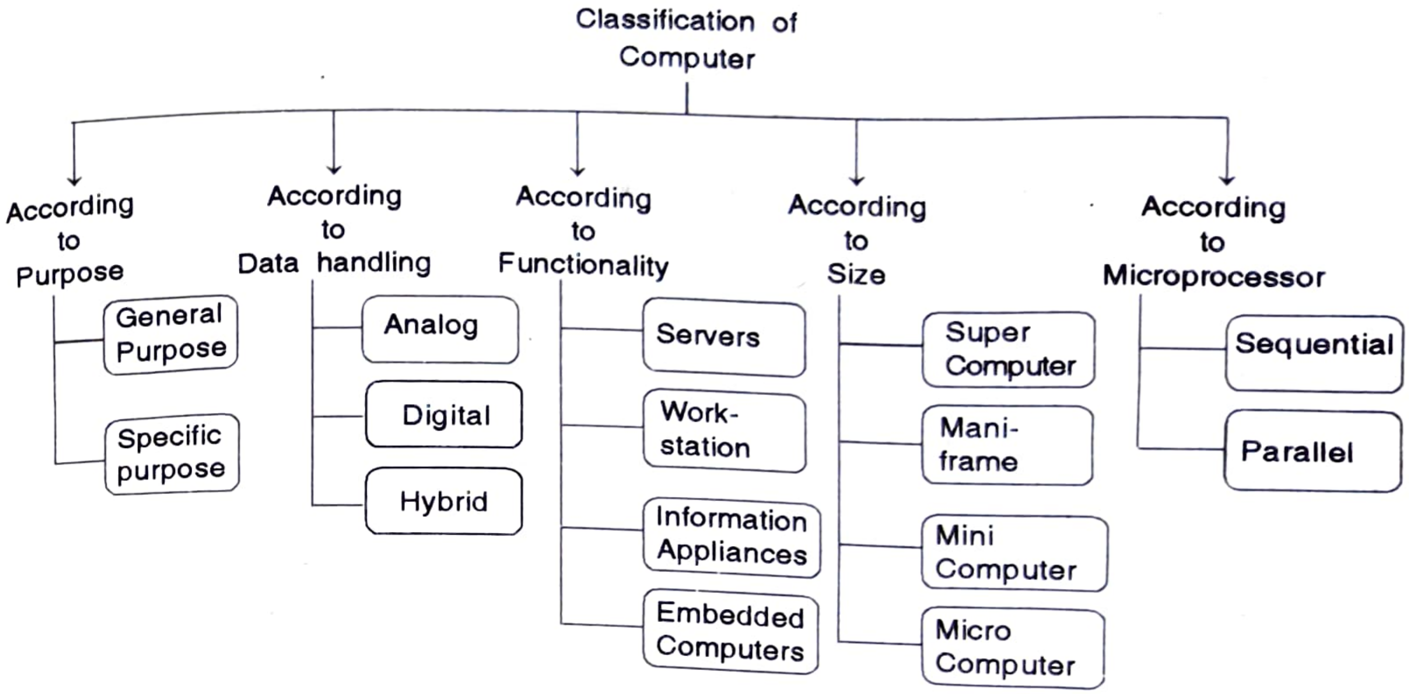
They can perform huge numerical and logical calculation when given proper instruction automatically. Even pilots can handover the controls to a computer as they can fly huge aircrafts which are called as Auto-Pilot Mode.

✓ No Feeling & No IQ

They do not have feeling and self IQ. They do not feel anything unlike humans i.e. tiredness, boredom, laziness, envy or jealousy. As they do not have their own IQ they entirely depend upon humans for inputs, the computer cannot take their own decisions based on logic.

PC has errors only when an input is wrong or incorrect.

1.3 CLASSIFICATION OF COMPUTERS


Classification of Computer
According to Purpose
General Purpose
Specific purpose
According to Data handling
Analog
Digital
Hybrid
According to Functionality
Servers
Work-station
Information Appliances
Embedded Computers
According to Size
Super Computer
Mani-frame
Mini Computer
Micro Computer
According to Microprocessor
Sequential
Parallel

I. According to purpose

✓ **General purpose computers** are the computers that can be used for all general needs of all environments and users. These are the versatile computers that can perform a variety of jobs for all types of environments as theyhave the ability to store numerous programs but may lack in speed and efficiency. The programs or instructions are fed to them and at the time of execution these computers process these instructions and produce meaningful results.

For example, a personal computer that is capable of calculating accounts data, preparing students result, designing broachers, writing letters, accessing Internet or playing games is a general-purpose computer.

✓ **Specific purpose computers** are designed to handle a specific problem or to perform a specific task. A set of instructions is built into the machine. These computers are not versatile. The instructions used by these computers are generally embedded in various automatic devices.

For example, a computer designed to display the path and trajectory of a missile can be only used for this purpose and we cannot use it for playing games. A computer that has been designed to count the telephone call pulses and the amount to be paid can only serve this purpose. We cannot use it for designing and word processing.

II. According to data handling

✓ **Analog computers** work on the principle of measuring, in which the measurements obtained are translated into data. It uses *continuous* physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved. Modern analogcomputers usually employ electrical parameters, such as voltages, resistances or currents, to represent the quantities being manipulated. Such computers do not deal directly with the numbers. They measure continuous physical magnitudes.

These computers are programmed for measuring physical quantities like pressure, temperature, speed, etc., and to perform computations on these measurements.Analog computers are mainly used for scientific and engineering applications.

Some of the examples of Analog computers are:

Thermometer: It is a simple analog computer used to measure temperature. In thermometer, the mercury moves up or down as the temperature varies.

Speedometer: Car's speedometer is another example of analog computer where the position of the needle on dial represents the speed of the car.

✓ **Digital computers** are those that operate with information, numerical or otherwise, represented in a digital form. Such computers process data into a digital value (in 0s and 1s). These types of computer performs calculations and logical operations with quantities represented as digits, usually in the binary number systemof "0" and "1". In other words, Digital computers are the computers capable of solving problems by processing information expressed in discrete form. From manipulation of the combinations of the binary digits, it can perform mathematical calculations, organize and analyze data, control industrial and other processes, and simulate dynamic systems such as global weather patterns. They give the results with more accuracy and at a faster rate.

✓ **Hybrid computers (Analog + Digital)** incorporate the measuring feature of an analog computer and counting feature of a digital computer. For computational purposes, these computers use analog components and for storage, digital memories are used.A combination of computers those are capable of inputting and outputting in both digital and analog signals. A hybrid computer system setup offers a cost effective method of performing complex simulations.

Hybrid computers are mainly used in artificial intelligence (robotics) and computer aided manufacturing (e.g., process control).For example, money counting machine and Automated Teller Machine (ATM).

III. Classification on the basis of functionality

✓ **Servers** : Servers are nothing but dedicated computers which are set-up to offer some services to the clients. They are named depending on the type of service they offered. For example, security server, database server.

✓ **Workstation** : Those are the computers designed to primarily to be used by single user at a time. They run multi-user operating systems. They are the ones which we use for our day to day personal / commercial work.

✓ **Information Appliances** : They are the portable devices which are designed to perform a limited set of tasks like basic calculations, playing multimedia, browsing internet etc. They are generally referred as the mobile devices. They have very limited memory and flexibility and generally run on "as-is" basis.

✓ **Embedded computers** : They are the computing devices which are used in other machines to serve limited set of requirements. They follow instructions from the non-volatile memory and they are not required to execute reboot or reset. The processing units used in such device work to those basic requirements only and are different from the ones that are used in personal computers- better known as workstations.

IV. On the basis of Size

✓ **Super Computer**

These are the fastest and most powerful type of computerand are employed for specialized applications that require immense amounts of mathematical calculations. For example, weather forecasting requires a supercomputer. Other uses of supercomputers include animated graphics, fluid dynamic calculations, nuclear energy research, and petroleum exploration.

Large scientific and research laboratories as well as the government organizations have extra ordinary demand for processing data which required tremendous processing speed, memory and other services which may not be provided with any other category to meet their needs. Therefore, they use Super Computers. These computers are extremely expensive, and the speed is measured in billions of instructions per seconds.

✓ **Mainframe Computer**

A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously. In the hierarchy that starts with a simple microprocessor (in watches, for example) at the bottom and moves to supercomputers at the top, mainframes are just below supercomputers. In some ways, mainframes are more powerful than supercomputers because they support more simultaneous programs. But supercomputers can execute a single program faster than a mainframe.

Mainframes are usually used by big organisations for bulk data processing such as statics, census data processing, transaction processing and are widely used as the severs, as these systems has a higher processing capability as compared to the other classes of computers. Most of these mainframe architectures were established in 1960s, the research and development worked continuously over the years and the mainframes of today are far better than the earlier ones, in size, capacity and efficiency. They have several hundreds of megabytes of primary storage and operate at a speed measured in nano second

✓ **Mini Computer**

The advent of minicomputers started in the 1960's when DEC (Digital Equipment Corporation) began shipping its PDP series computers. The press named them minicomputers because of their small size as compared to other prevailing computers. The easiest way to describe minicomputers is by saying that they lie somewhere in between mainframes and microcomputers. They can handle a great amount of data like mainframes. They can also support a number of terminals just as mainframes do. Although they are designed for hundreds of terminals, they differ in speed, i.e. minicomputers are slower than mainframes and they cannot support as many terminals as mainframes can. They have less storage capacity and their printers too are slow. In other words, Mini computers are smaller than mainframes, both in size and other facilities such as

✓ **Software** : A computer system cannot do anything its own, it must be instructed to do a desired job. Hence, it is necessary to specify a sequence of instructions that a computer must perform to solve a problem. Such a sequence of instructions written in a language that can be understood by a computer is called a computer program. It is the program that controls the activity of processing by the computer; and the computer performs precisely what the program wants it to do. The term software refers to the set of computer programs, procedures and associated documents. Precisely, software means a collection of programs whose objective is to enhance the capabilities of the hardware machine. Software consists of the programs and applications that run on computers. It provides instructions for the hardware to accomplish tasks. Because software runs on computer hardware, software programs often have system requirements that list the minimum hardware required for the software to run. There are two types of software – System and Application Software (discussed in detail in Chapter 4)

✓ **Firmware** : In electronic and computing, firmware is a term often used to denote the fixed, usually rather small, programs and/or data structures that internally control various electronic devices. Typical examples of devices containing firmware range from end-user products such as remote controls or calculators, through computer parts and devices like hard disks, keyboards, or memory cards, all the way to scientific instrumentation and industrial robotics. Also more complex consumer devices, such as mobile phones, digital cameras, synthesizers, etc., contain firmware to enable the device's basic operation as well as implementing higher-level functions. There are no strict boundaries between firmware and software, as both are quite loose descriptive terms. However, the term firmware was originally coined in order to contrast to higher level software which could be changed without replacing a hardware component, and firmware is typically involved with very basic low-level operations without which a device would be completely non-functional. Firmware is also a relative term, as most embedded devices contain firmware at more than one level.

Subsystems such as CPUs. flash chips, communication controllers, LCD modules, and so on, have their own usually fixed) program code and/or microcode, regarded as "part of the hardware" by the higher-level (s) firmware. Low-level firmware typically resides in a ROM, while higher level firmware (often on the border to software) typically employs flash memory to allow for updates, at least in modern devices. (Common reasons for updating firmware include fixing bugs or adding features to the device. Doing so usually involves loading a binary image file provided by the manufacturer into the device, according to a specific procedure; this is sometimes intended to be done by the end user.) Thus, while high-level firmware (or software) typically is stored as a configuration of charges, low-level firmware may instead often be regarded as actual hardware in itself. Firmware is software that is "built-in" to the hardware, but such firmware is usually the province of computer programmers and computer engineers in any case and not an issue that computer users need to concern themselves with.

✓ **Humanware** : Computer is automatic, but under the supervision of human. It need human to activate (initialize) it before the combination of hardware/software can execute any job (work). Humanware (also known as peopleware) doesn't include those whocan not operate computer. Humanware includes programmer, operator, etc.,i.e. anybody who can guide computer to perform (execute) task.

In other words, the computer is made of two wares (which are hardware and software). But for a computer to carry out any operation, three wares are needed which include the above mentioned two and the humanware. The computer work on data and these data will be fed via its' input device into the computer. Humanware is those responsible for inputting data. Without the humanware the computer set is more like an artwork (decoration). Humanwarecan also be defined as hardware or software that is built around user capabilities and user needs. This often involves creating a particular visual or physical interface for a given set of users. The design and engineering of humanware starts with the user's interests and needs first, and designs the infrastructure accordingly. Typically, a great deal of testing is done on software packages and hardware parts to ensure they enhance the end-user experience to aid in creating documents, musical and video recordings, and all forms of raw and finished data.

REVIEW QUESTIONS

1. Define the terms :
   - Computer
   - Hardware
   - Software
   - Firmware
   - Humanware
2. Explain the block diagram of computer.
3. Describe the characteristics of computer.
4. Elucidate various advantages and disadvantages of computer.
5. Explain the classification of computers.

OO

2
CHAPTER

Input Output Devices

LEARNING OUTCOMES

☐ Input Devices
☐ Output Devices

2.0 INTRODUCTION

Without Communication computers are of no use. For this man to machine communication peripheral devices are important.

A **peripheral device** is an internal or external device that connects directly to a computer but does not contribute to the computer's primary function, such as computing. It helps end users access and use the functionalities of a computer. A peripheral device provides input/output (I/O) functions for a computer and serves as an auxiliary computer device without computing-intensive functionality. Peripheral devices connect with a computer through several I/O interfaces, such as communications (COM), Universal Serial Bus (USB) and serial ports. These peripheral devices are classified as Input and Output Devices.

The devices which are used to input the data and the programs in the computer are known as **"Input Devices"**, or Input device can read data and convert them to a form that a computer can use. Output Device can produce the final product of machine processing into a form usable by humans.

Various Input and Output devices are discussed in detail in the following sections.

2.1 INPUT DEVICES

An input device can be defined as an electromechanical device that allows the user to feed information or data into the computer for analysis, storage and give command to the computer. Input devices accept data and instructions from the user. Generally, input devices are manual or direct entry devices. Various input devices are discussed below.

2.1.1 Keyboard

A keyboard is an input device used to enter commands and data into the computer. It has keys similar to a typewriter to enter characters and other symbols. It contains a total of 101 to 104 keys. The latest keyboard (Windows keyboard) is available with 104 keys.

When a key is pressed, the electric circuitry under the key changes. Such changes are detected by the microprocessor and the binary code for the character is sent to the CPU. Some keyboards have a temporary memory or buffer to store the information typed a little ahead of the need of the computer. The different types of keys on a standard keyboard are listed below:

- ✓ **Alphanumeric Keys** : These keys are used for entering letters and numbers.
- ✓ **Special Keys** : Keys such as Control (CTRL), SHIFT, SPACEBAR, ALT, CAPS LOCK, and TAB are special keys. These special keys perform special functions depending on when and where they are used.
- ✓ **Punctuation Keys** : Punctuation keys include keys for punctuation marks, such ascolon (:), semicolon (;), question mark (?), single quotation marks (‘), and doublequotation marks (“ “).
- ✓ **Command Keys** : Keyssuchas INSERT(INS), DELETE(DEL),and BACKSPACE are command keys. One can use these keys to insert and delete text and objects. One can turn the INSERT key either ON or OFF. When turned ON, the INSERT key helps to overwrite characters to the right of the insertion point. When turned OFF, the INSERT key helps to enter text or characters to the right of the insertion point, without overwriting this text or characters. An insertion point is the blinking vertical line that indicates the location at which the inserted text appears. The DELETE key is used to remove typed text, characters, and other objects on the right side of the insertion point. The BACKSPACE key is used to remove typed text, characters, and other objects on the left side of the insertion point.
- ✓ **Enter or Return Key** : The label on this key can be either ENTER or RETURN, depending on the brand of computer that one is using. The ENTER or the RETURN key can be used to move the insertion point to the beginning of a new line. In some programs, it is used to send commands and to confirm a task on a computer.
- ✓ **Navigation Keys** : Keys such as the arrow keys, HOME, END, PAGE UP, and PAGE DOWN, are navigation keys. The arrow keys can be used to move the insertion point up, down, right, and left. The HOME key is used to move the cursor to the left end of a line of text or the top of a document. The END key, in contrast, moves the cursor to the end of a line or a file, depending on the program. The PAGE UP key is used to move one page up

and the PAGE DOWN key is used to move one page down while viewing a document. The functions of PAGE UP and PAGE DOWN keys differ from program to program.

✓ **Function Keys** : Keys labelled from F1 to F12 are function keys. These are used to perform specific functions. Their functions differ from program to program. The function of the F1 key in most programs is to access the help file associated with a program. Some keyboards may have fewer function keys.

✓ **Numeric Keypad** : Not all keyboards has a numeric keyboard. If available, this is a separate set of keys with numbers from 0 to 9, the decimal point, special characters, and navigation symbols. The NUM LOCK key on this keypad allows to switch between the numeric and the navigation keys.

✓ **Windows Key** : The key between the CTRL key and the ALT key is the Windows key. it has the Microsoft Logo or the Windows flag. This key is used to open the Start menu or is used in combination with a second key to perform common Windows tasks. The exact use of the Windows key may vary from program to program.

Different types of keyboard are available in market depending on the size and their connectivity to the computer.

✓ Advantages of Keyboard

- Simple and easy to use
- Potentially a fast way to enter data

✓ Disadvantages of Keyboard

- A slow way to enter lots of data if not a trained typist
- Mistakes can be made if not careful

2.1.2 Mouse

A mouse is a pointing input device used to select a command by moving it in any direction on a flat surface. It can be used to move, select, and open items displayed on the monitor. Most mouse devices have a wheel that helps to scroll through documents or pages. There are different types of mouse devices available in the market.

- **Normal Mouse (with Cable)** : The most used mouse are cable mouse, these are those mouse which we uses in our home commonly, they connect through a wire to computer. A regular mouse has a rubber or a metal ball on the underside. The mechanical movement of the mouse device moves the ball. This movement further moves the pointer on the screen.
- **Trackball** : A trackball is like a regular mouse, but upside down, with the ball on the top. It allows to have the same control as a mouse in a confined space. An optical mouse can be used in the same way as a regular mouse. However, it does not have a ball, but uses a laser to detect movement.
- **Wireless Mouse** : Most of wireless mouse uses radio frequency to connect with a computer, it has a Transmitter and a Receiver. Transmitter catches the movement of hands, changes them into signal and sends to computer. While receiver catches those signals (sent by transmitter), then changes into computer language and forwards to mouse driver. That's how a wireless mouse works. Wireless mouse can further be classified as:
  - **Bluetooth Mouse** : Bluetooth mouse also works on radio frequency, with the Bluetooth technique one can connect mouse, keyboard, printer, headset and other devices as well. But to connect all these devices, the computer must have Bluetooth adaptor, so that the computer may allow Bluetooth and get signal. The range of Bluetooth Mouse is almost 33 feet or 10 meter.
  - **USB Mouse:** To use this connect a receiver as a USB with the computer. This takes signals from that mouse which is connected to the computer. The range of this mouse is also 10 meters.

Most mouse devices have a left and right buttons. Most of the actions are performed by clicking the left button. The left button can be used to select items and provide instructions by clicking an active area on the screen. The right button can be used to display commonly used menu items on the screen. The options on this menu include the most common tasks, such as copying text from one location and pasting it to another location. These are called context-sensitive menus. These menus help to complete tasks quickly. When the mouse is rolled across a flat surface, a pointer moves correspondingly on the screen. The mouse allows to select an item on the screen. As the pointer is moved over different areas of the screen, the items or the pointer change. These changes indicate that one can click an item to open it, or see more of its options. An item can be opened by moving the pointer to it,and clicking the left mouse button twice.

✓ **Advantages of Mouse**

- They are helpful in data entry work with keyboard.
- It can be connected in any computer system.

✓ **Disadvantages of Mouse**

- They need a flat surface to work; if the surface is not flat then one may face many challenges as well.

- People with restricted hand/wrist movement may not find it easy to use.
- Some mouse loses their accuracy and speed.
- Wireless mouse works on battery so if battery drains then it can't be used till the battery is refilled.

2.1.3 Joystick

A joystick is an input device commonly used to control video games. Joysticks consist of a base and a stick that can be moved in any direction. The stick can be moved slowly or quickly and in different amounts.

There are **different types of joysticks such as displacement joysticks, hand-operated joysticks, finger-operated joysticks, thumb/fingertip-operated joysticks, hand-operated isometric joysticks,** etc.

Some joysticks have sticks that can also be rotated to the left or right. Because of the flexible movements a joystick allows, it can provide much greater control than the keys on a keyboard. Joysticks typically include several buttons as well. Most joysticks have at least one button on the top of the stick and another button in the front of the stick for the trigger. Many joysticks also include other buttons on the base that can be pressed using the hand that is not guiding the stick. Joysticks typically connect to the computer using a basic USB or serial port connection and often come with software that allows to assign the function of each button. Since joysticks emulate the controls of planes and other aircraft, they are best suited for flight simulators and flying action games. However, some gamers also like to use joysticks for other types of video games, such as first-person shooters and fighting games.

✓ Advantages of Joystick

- It is useful for playing computer and video games.
- It is very easy to use by beginners.
- It is very fast interface.
- It is easier to navigate.
- The control is in 3D (three dimensions).
- They provide fast interactions as required in most games and hence used in games such as racing or flying styles etc.

✓ Disadvantages of Joystick

- It is difficult to control the ON screen pointer compare to mouse.
- Some people find it more difficult to control than mouse.
- Movement indirect in plane different from the screen.
- They are not robust and can break if too much force is applied on them.

- It requires lifting of hand from keyboard keys and requires different hand movements.
- The prolonged use of joystick can cause fatigue in the arms.

2.1.4 Scanner

A scanner is a peripheral input device used to assist in the entry of data into a computer system. This device can be used to transfer an exact copy of a photograph or document into a computer. A scanner reads the page and translates it into a digital format, which a computer can read. In desktop publishing, a scanner may be used to digitize artwork or photographs so that they can be merged with text. Scanners are used to scan a printed page or an illustration. These data are then converted into bit patterns for processing storage or output. When an image is scanned, it is converted into light and dark picture elements or pixels. The scanned images are used for word processing and printing multiple copies. Scanners are also useful to scan fingerprints. The scanned fingerprints can be compared with another fingerprint to find probable match in investigative services. Photoelectric scanners are commonly used in supermarkets to read barcodes

The common optical scanner devices are Magnetic Ink Character Recognition (MICR), Optical Mark Reader (OMR) and Optical Character Reader (OCR). They are briefly discussed below:

- **Magnetic Ink Character Recognition (MICR)**: This is widely used by banks to process large volumes of cheques and drafts. Cheques are put inside the MICR. As they enter the reading unit the cheques pass through the magnetic field which causes the read head to recognize the character of the cheques.
- **OpticalMarkReader(OMR)**: Thistechniqueisused whenstudents have appeared in objective type tests and they had to mark their answer by darkening a square or circular space by pencil. These answer sheets are directly fed to a computer for grading where OMR is used.
- **Optical Character Recognition (OCR)**: This technique unites the direct reading of any printed character. Suppose one have a set of hand written characters on a piece of paper. The paper will be put inside the scanner of the computer. This pattern is compared with a site of patterns stored inside the computer. Whichever pattern is matched is called a character read. Patterns that cannot be identified are rejected. OCRs are expensive though better than MICR.

Different types of scanners available in market are:

- **Flatbed Scanners**

  The type of image scanning device seen most often around the office is a flatbed scanner. This looks just like the work surface of a photocopier, where one put the page to be copied, and that's pretty much what a flatbed scanner is. It can also be used to scan thick original items, like books or magazines, as well as single pages.

  Most printer manufacturers offer multifunction laser or inkjet printers with scanning ability built in, so there is no need to make space for a separate scanner that might not see a lot of use. Multifunction printers give the additional perk of acting as a copier or sometimes a fax machine, as well as printing and scanning. That makes them a good option in a small office, where a "jack of all trades" device is often more practical than buying several separate machines.

- **Sheet-Fed Scanners**

  Flatbed scanners are simple and easy to use, but they're really only meant for scanning one page at a time. If one is scanning a longer document, doing one page at a time gets old in a hurry. If multipage documents are a frequent part of doing business, one might be better off with a sheet-fed scanner. This type has an input tray holding anywhere from a handful of pages to dozens, and feeds them through in much the same way paper feeds through a printer. Some models even offer duplex printing, meaning they'll scan both sides of a double-sided document at the same time. That can be a serious time-saver.

- **Handheld Scanner**

  A handheld scanner is a small manual scanning device which is moved over the object that needs to be scanned. In flatback and sheetfed scanners, the document that is to be scanned is put inside the device. In contrast, in the case of heldheld scanner, it have to be dragged over the document that is to be scanned. Using a handheld scanner can be a cumbersome task as the hand needs to be steady all the time. Even a slight movement of hand can lead to distortion of the image. One of the most-utilized handheld scanner is the barcode scanner, typically used in shopping stores to valuate goods.

- **Large-Format Scanners**

  Flatbed scanners and sheet-fed scanners are both versatile business machines, but they're usually pretty limited in the sizes they can scan. If one work with larger pages in the business – such as blueprints, architectural drawings or posters –a large-format scanner is needed. These rather resemble a musician's electronic piano, with a flat scanning mechanism mounted atop a stand that brings it up to desk height. To use it, slide the oversized original into the scanner until the rollers grip it and position it for scanning. From there, it works much like a jumbo sheet-fed scanner, with the document sliding through the scanning mechanism and coming out the other side.

- **Drum Scanners**

  A drum scanner is the one which uses a photomultiplier tube (PMT) to scan images instead of the charge-coupled device that is typically used in a flatbed scanner. Photomultiplier tubes are vacuum tubes which are extremely sensitive to light. In drum scanners, the image is mounted on the glass tube. When the beam of light moves across the image, its reflection is picked up by the PMT and processed. Drum scanners are known for their high resolution, which makes them apt for detailed scans. If they are not as popular as flatbed scanners, it is because of their cost and large size.

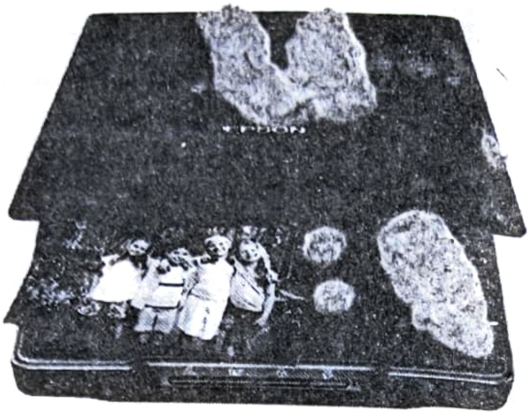
- **Portable Scanners**

  Being small in size, portable scanners can be easily carried around. Some of these are so small, that they can be carried in the pockets. They are of great help when it comes to text document scanning. Their drawback though, is their limitation in terms of resolution. They cannot be used for scanning photographs or for applications which require high-resolution scanning.

- **Photo Scanner**

  As the name itself suggests, a photo scanner is mostly used to scan photographs. It boasts of high resolution and color depth, both of which are necessary for scanning photographs.

While flatbed scanners can also scan the photographs, they are not as fast as dedicated photo scanners. It's also worth noting that the in-built software in some photo scanners helps in cleaning and restoring old photographs.



✓ **Advantages of Scanners**

- Flatbed scanners are very accurate and can produce reasonably high-quality images.
- Any image which is digitised by the scanner can then be included on electronic documents.
- Images once digitised can be enhanced with graphic applications.
- It can accurately capture an image, but the original source may be more important than the scanned image.

✓ **Disadvantages of Scanners**

- Images produced by scanner can take up a lot of memory space.
- Images lose some quality in the scanning and digitising process.
- The quality of the final image is dependent on the quality of original image.

2.1.5 Bar Code Reader

A barcode reader, also called a price scanner or point-of-sale (POS) scanner, is a handheld or stationary input device used to capture and read information contained in a bar code. A barcode reader consists of a scanner, a decoder (either built-in or external), and a cable used to connect the reader with a computer. Because a barcode reader merely captures and translates the barcode into numbers and/or letters, the data must be sent to a computer so that a software application can make sense of the data.

✓ **Different types of barcodes**

There are primarily 2 different types of barcodes: 1D and 2D. The kind of barcode needed to use depends on how much data oneintends to store in the barcode.

o 1D code

These codes, like the UPC code, are generally linear black and white spaces of varying widths. They will have close to 12 characters. The disadvantage of the 1D code is that the more information you want to include, the longer the barcode will become.

123456789

o 2D code

2D code, like QR codes and data matrix use squares, hexagon and other shapes to store data.

It is read in 2 dimensions as data is arranged in both horizontal as well as vertical patterns.

It can be much smaller than the 1D code but can carry up to 100 characters, and thus hold much more information. Another advantage is that while 1D can carry only alpha-numerics, whereas 2D codes can carry other kinds of information like images, website address, voice, and other types of binary data.

The 1D code can be read with the traditional laser scanners or camera-based imaging scanners. But 2D codes can be read only using imagers, which are more expensive.

A barcode requires a specific type of scanner, called the 'barcode scanner' to scan this code. The scanned output is transmitted to the computer using this device. There are various types of barcode scanners available in the market are discussed below :

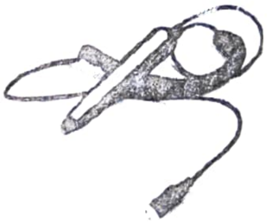
✓ Types of barcode scanners

There are primarily 4 different barcode scanners types, based on the technology they use to scan.

o Pen type readers

They are also called barcode wands because they look like wands. This scanner consists of a LED light and a photodiode at its tip. How it works is that, when this pen-like barcode scanner is slid over the barcode, the LED illuminates the black and white bars. The light reflected from these bars, which vary depending on their thickness, is captured by the photodiode and is later converted into digital information.

The problem with this type is that you have to carefully pass the scanner over the barcode and at the proper speed. The scanner needs to come in contact with the barcode. Any kind of human error could lead to flaws in the data obtained.Pen type barcode scanners are the least expensive among all.



o Laser barcode scanners

These are the most popular type of barcode scanners and are widely used in retail. They also work similar to the pen-type but give accurate results when compared to the former.

In this type, a laser beam is shot at a mirror within the actual unit. This mirror moves within so that the laser sweeps across the barcode in a straight line. A photodiode captures the reflected light and converts it into digital information.

This type can be either hand-held or mounted. A standard-range laser barcode can read the code from 6 to 24 inches away. A long range one can read from 2 to 8 feet away, and an extra-long one from up to 30 feet away.

- **CCD barcode scanners (Charge Coupled Device)**

CCD scanners are expensive units but give very accurate results. You may see them referred to as LED scanners.

They have hundreds of tiny LED lights arranged in a row within the unit. This is directly shot at the barcode, and the voltage of the ambient light is measured. This is later converted to computer readable data.

These are widely popular in POS(Point of Sale) applications.

But, the disadvantages of CCD scanners are that you need to hold them within 1 to 3 inches from the barcode, and it cannot read the code that gets longer than its scanner face.

- **Imager barcode scanner (Camera-based)**

These function more like a video camera rather than a scanner.

The unit consists of a video camera within, and rather than using the laser to shoot light at the code, it essentially takes a picture of the barcode, which is then analyzed using sophisticated digital decoding techniques.

The main advantage of this type is that they can read the barcode no matter how you place the scanner in front of it. This increases the speed of scanning multi-fold.

As mentioned earlier, 2D barcodes consist of different types of shapes, unlike the linear spaces in 1D. Hence, an ordinary scanner cannot serve the purpose of scanning 2D barcode. So, only images can do this job.

✓ **Based on the type of connectivity, scanners can be classified ascordless and corded barcode scanners.**

Cordless scanners are best suited for warehouse or factory applications, where a cord could restrict the movement. Also, under harsh environments where the cable could get damaged, cordless scanners are the right choice. For heavy, bulky items that are difficult to place at the checkout counter, cordless scanners are the best choice.

2.1.6 Various Other Input Devices

- **Track pad is a pointing input device.** It is used in Lap top computers to control motion of pointer on screen. Track pad is a stationary input device. It has a flat surface of 1.5 to 2 square inch. Finger is moved on this surface to move pointer on screen.
- **Light pen is an input device consisting of a special pen** that is connected to a computer's monitor. The user points at the screen with the pen and selects items or chooses commands either by pressing a clip on the side of the light pen or by pressing the light pen against the surface of the screen (the equivalent of performing a mouse click).
- **Microphone is an input device used to enter sounds into the computer.** The sounds can be recorded in computer with the help of microphone and sound card.
- A **graphics tablet** consists of a special pen called stylus and a flat pad. The image is created on the monitor screen as the user draws it on the pad with the help of stylus (special pen). Graphics tablet is also called a digitizer.
- **A digital camera is one of the latest input devices.** The pictures can be taken with the help of digital camera. These pictures are saved on digital camera's internal memory. There is no need of a film role as used in traditional cameras. Later on these pictures can be easily input with the help of a data cable into computer's memory. Latest digital cameras can take still snapshots and can record video as well.

2.2 OUTPUT DEVICES

An output device is any peripheral that receives data from a computer, usually for display, projection, or physical reproduction. Output devices are varied and as innovative as input devices. From traditional printed output to audio output and robots, there is a multitude of forms of computer output.

Most output can be divided into two categories: soft copy and hard copy. Soft copy is ideal while writing a document, playing a game, watching a video clip, or reading the latest news. Soft copy is what one can see on the monitor. It is temporary; after one have finished with it, there is nothing solid to hold. However, soft copy can be transferred to a disk to transport it. Hard copy on the other hand, can be touched and carried. It is usually some form of paper output. It is especially helpful if you need to have a colleague look at your work or you need to give your work to a supervisor or a teacher. Various output devices are discussed below.

2.2.1 Monitor

One of the most important output devices in computer system is its screen commonly called monitor.A computer monitor, technically termed as a visual display unit, can be plainly described as an electronic device that transmits information from the computer onto a screen, thereby acting as an interface and connecting the viewer with the computer. It is an output device and displays all the programs and applications which are running on the computer system. It displays images generated from the video output. It displays images without keeping a permanent record. A Graphic display is made up of a series of dots called 'pixels' (picture elements) whose pattern produces images in computer system. Each dot on the screen is defined as a separate unit which can be addressed separately. Since each dot on the screen can be controlled separately it gives greater flexibility in drawing pictures. The Number of dots per inch (dpi)is called the resolution of the screen and represents the quality of the computer system.

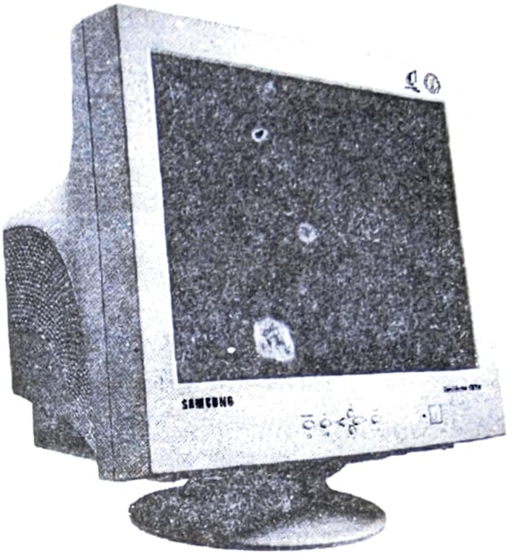
At present, computer monitors are available in a variety of shapes, designs, and colors. It can be color or monochrome. A monochrome monitor is a type of CRT computer display, which was very common in the early days of computing. from the 1960s through 1980s, before color monitors became popular. They are still widely used in applications such as computerized cash register systems.

Older computer monitors were built using cathode ray tubes (CRTs), which made them rather heavy and caused them to take up a lot of desk space. Most modern monitors are built using Liquid Crystal Display (LCD) technology and are commonly referred to as flat screen displays. These thin monitors take up much less space than the older CRT displays. This means people with LCD monitors have more desk space to clutter up with stacks of papers, pens, and other objects. So, based on the technology used to make computer monitors, they can be broadly categorized into three types.

- ✓ CRT (Cathode Ray Tube)
- ✓ LCD (Liquid Crystal Display)
- ✓ LED (Light-Emitting Diodes)

CRT (Cathode Ray Tube) Monitors

These monitors employ the CRT technology used most commonly in the manufacturing of television screens. In this, a stream of intense high energy electrons is used to form images on a fluorescent screen. A cathode ray tube is a basically a vacuum tube containing an electron gun at one end and a fluorescent screen at another end. From this electron gun, a process called thermionic emission generates a strong beam of electrons. These electrons travel through a narrow path within the tube with high speed using various electro-magnetic devices and finally strike the phosphor points present on the fluorescent screen, thus creating an image.



✓ Advantages of using CRT monitors

- These monitors are highly reliable and efficient, and are capable of generating a resolution of up to 2048 x 1536 pixels, thereby providing a clear picture quality. Also, CRT monitors that are now available are capable of producing thousands of different colors.
- Secondly, CRT monitors are affordable and cost effective.
- Unlike conventional CRT monitors, modern technological advancements have resulted in the development of flat screen CRT monitors that reduce the glare and are good for the eyes.

✓ Disadvantages of using CRT monitors

- They are heavy and can occupy a great deal of work space.
- These devices get heated up very easily.

LCD (Liquid Crystal Display) Monitors

Liquid crystal display, also known as liquid crystal diode, is one of the most advanced technologies available at present. Typically, an LCD monitor consists of a layer of color or monochrome pixels arranged schematically between a couple of transparent electrodes and two polarizing filters. Optical effect is achieved by polarizing the light in varied amounts and making it pass through the liquid crystal layer. At present, there are two types of LCD technology available. These include the active matrix or TFT and a passive matrix technology. Among these, TFT technology is more secure and reliable, and generates better picture quality. On the other hand, passive matrix has a slow response time and is slowly becoming outdated. In recent times, LCD monitors have become increasing popular with consumers.

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✓ **Advantages of LCD monitor**

- These monitors are compact, lightweight, and do not consume much desk space.
- These monitors do not consume much electricity and can even be operated by using batteries.
- The images transmitted by these monitors do not get geometrically distorted and have little flicker.

✓ **Disadvantages of LCD monitor**

- These monitors are very expensive.
- Image quality is not constant when viewed from different angles.
- LCD monitor's resolution is always constant. Any alterations can result in a reduced performance.

LED (Light-Emitting Diodes) Monitors

LED monitors are the latest types of monitors in the market today. Like LCD, it is again a flat panel display making use of light-emitting diodes for back-lightning instead of Cold Cathode Fluorescent (CCFL) back-lightning used in LCDs. Primarily, the display is of LCD only but the back-lightning is done by LEDs.

LED monitors are said to use much lesser power than CRT and LCD. Thus, they are also considered environmental friendly.

✓ **Advantages of LCD monitor**

- They produce images with higher contrast
- They have less negative environmental impact when disposed
- Lifespan and durability of LED monitors is more than CRT or LCD monitors
- Because of the technology, the monitor panels can be made very thin
- Do not produce much heat while running

✓ **Disadvantages of LCD monitor**

- LED monitors are little expensive than the former types.

2.2.2 Printer

A printer is an output device that prints characters, symbols, and perhaps graphics on paper. The printed output is generally referred to as **hardcopy** because it is in relatively permanent form. There are two types of printers- Impact printers and Nonimpact printers.

(A) **Impact printers** : An impact printer has mechanisms resembling those of a typewriter. It forms characters or images by striking a mechanism such as a print hammer or wheel against an inked ribbon, leaving an image on paper.

(*i*) **Dot-Matrix Printers** : The most popular kind of printer for small computers is the dot matrix printer, which forms characters as arrays of dots. Dot matrix printers are compact, reliable and relatively fast. The print head is the important hardware which produces the character using pins arranged in a matrix form. A dot-matrix printer contains a print head of small pins that strike an inked ribbon, forming characters or images. Normally a print head has 9, 18, or 24 pins arranged in a matrix form. Combinations of pins strike an ink bed ribbon during the printing process. The print head moves in a line and the pattern of dots required for each character is printed on the paper. After printing a line, the paper rolls to print the next line.

Dot-matrix printers permit a choice between output of draft quality; a coarser-looking 72 dots per inch vertically, which may be acceptable for drafts of papers and reports, and near-letter-quality, a crisper-looking 144 dots per inch vertically, which is more suitable for a finished product to be shown to other people.

Dot-matrix printers print about 40-300 characters per second (cps) and can print some graphics, although the reproduction quality is poor. Color ribbons are available for limited use of color. Dot-matrix printers are noisy, inexpensive, and they can print through multipart forms, creating several copies of a page at the same time.

Dot matrix printers produce average quality prints and are generally used in business applications. They are used printing train number, seat number etc on a railway reservation ticket. The speed of printing in dot matrix printer is measured in characters per second (cps).

✓ Advantages of Dot-matrix printer

- Carbon copies can be obtained as printing takes place by physical impact with the paper
- Cost less
- Easy to maintain

✓ Disadvantages of Dot-matrix printer

- Average printing quality
- Printer ribbon needs to be changed frequently

(*ii*) **Daisy-Wheel Printer** : A type of printer that produces **letter-quality type**. Daisy-wheel is a **serial printer**. A daisy-wheel printer works on the same principle as a **ball-head typewriter**. The daisy wheel is a **disk made of plastic or metal** on which characters stand out in relief along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. Then a **hammer**

strikes the disk, forcing the character to hit an ink ribbon, leaving an impression of the character on the paper. The daisy wheel can be changed to print **different fonts**.

Daisy-wheel printers **cannot print graphics**, and in general they are **noisy and slow**, printing from **10 to about 75 characters per second**. As the price of laser and ink-jet printers has declined, and the quality of dot-matrix printers has improved, daisy-wheel printers have become obsolete.

(*iii*) **Line Printer** : The various types of line printers are as follows:

- **Drum Printer**

An impact printer in which a complete set of characters for each print position on a line is on a continuously rotating drum behind an inked ribbon, with paper in front of the ribbon; **identical characters are printed simultaneously** at all required positions on a line, on the fly, by signal-controlled hammers.

- **Chain Printer**

It is the **character printer**. The print element in a **chain printer is a metallic band or chain containing the embossed characters** that rotates horizontally in front of paper. A complete chain consists of the **five sections**; each section consists of **48 characters**. As the print chain rotates, properly timed print **hammers strike** the paper along with linked ribbon, against the **proper character on the chain** as it passes. Chain printer are one of the **fastest impact printers**that can produce up to **400 to 2500 characters per second**. Chain Printer also called **band printers**, contain **characters on a rotation band**. Speeds of up to **3000 lines a minute** may be possible with these machines.

✓ **Advantages of Line printers**

- A **high-speed printer capable of printing an entire line at one time**. A fast line printer can print as many as **3,000 lines per minute**.

✓ **Disadvantages of Line printers**

- They **cannot print graphics**
- The **print quality is low**
- They are **very noisy**.

B. **Nonimpact Printers** : Nonimpact printers, used almost everywhere now, are faster and quieter than impact printers because they have fewer moving parts. Nonimpact printers form characters and images without direct physical contact between the printing mechanism and the paper.

Two types of nonimpact printers often used with microcomputers are laser printers and ink-jet printers.

(*i*) **Laser Printer** : Like a dot-matrix printer, a laser printer creates images with dots. However, as in a photocopying machine, these **images are created on a drum**, treated with a **magnetically charged ink-like toner** (powder), and then transferred from drum to paper.In these printers, the controlled beam of intense laser forms images on an electrically charged rotating drum. These charged images sticks to the paper due to pressure and heat. The toner consists of oppositely charged ink particles which stick to the drum in the places where the laser has charged. The light beam strikes a multi-sided rotating mirror. As the mirror rotates, the side currently in the path of the light beam sweeps the beam across the surface of the drum. As the beam sweeps across the drum, the light is modulated and a single line is drawn. After a line has been drawn, the next side of the mirror is in place and a new line is drawn below the previous line.

The quality of the printout is measured by the number of dots per inch (dpi). Since the dots are printed closely, the text or graphics appears very smooth and elegant. The speed is measured in number of pages printed per minute (PPM).

There are good reasons why laser printers are so popular. They produce **sharp, crisp images** of both text and graphics, providing resolutions from **300 dpi up to 1200 dpi**, which is **near-typeset quality** (NTQ). They are quiet and fast. They can print **4-32 text-only pages per minute** for individual microcomputers, and more than **120 pages per minute for mainframes**. (Pages with more graphics print more slowly.) They can **print in many fonts** (type styles and sizes). The more expensive models can print in different colors.

Laser printers have **built-in RAM chips** to store documents output from the computer. If you are working in desktop publishing and printing complicated documents with color and many graphics, you will need a printer with a lot of RAM. Laser printers also have their own ROM chips to store fonts and their own small dedicated processor. To be able to manage graphics and complex page design, a laser printer works with a page description language, a type of software that has become a standard for printing graphics on laser printers. A PDL (**page description language**) is software that describes the shape and position of letters and graphics to the printer.

✓ Advantages of Laser printers

- Good quality printouts can be obtained
- Printing is faster
- Easy to handle and maintain

✓ Disadvantages of Laser printers

- High price and higher print cost

(ii) **Ink-jet printer** : Like laser and dot-matrix printers, ink-jet printers also form **images with little dots. Ink-jet printers spray small, electrically charged droplets of ink** from four nozzles through holes in a matrix at high speed onto paper. The print heads move across the page by the control of software and spray the dots of ink with the required combination of colors. The printer sends electrical pulses to thin resistors at the base of firing chambers behind the nozzle. A thin layer of ink is heated by the resistor which in turn forms a vapour bubble and the expansion forces ink through the nozzle and onto the paper at a rate of about 6000 dots per second.

Ink-jet printers can **print in color** and are quieter and much less expensive than a color laser printer. However, they are slower and print in a somewhat lower **resolution** (300-720

dpi) than laser printers. Some new, expensive ink-jet printers print up **1200 or 1400 dpi**. High resolution output requires the use of special coated paper, which costs more regular paper. And, if you are printing color graphics at a high resolution on an ink-jet printer, it may take 10 minutes or more for a single page finish printing.

The black inkjet printer uses black cartridge filled with black ink whereas the color printer uses four color cartridges namely cyan (blue), magenta (red), yellow and black. These four colors are used in combination to generate any color in the visible spectrum.

A variation on ink-jet technology is the **bubble-jet printer**, which use miniature heating elements to force specially formulated inks through print heads with **128 tiny nozzles**. **The multiple nozzles print fine images at high speeds**. This technology is commonly used in portable printers.

✓ **Advantages of Inkjet printers**

- Low cost.
- Quality of printing is same as laser printer.
- Color printouts are cheaper.
- Easy to handle and maintain.

✓ **Disadvantages of Inkjet printers**

- Ink cartridges may get spoiled in not used for long time.
- Some inkjet printers are expensive.

2.1.1 Plotters

A plotter is a special output device used to produce hardcopies of graphs and designs on the paper. A plotter is typically used to print large-format graphs or maps such as construction maps, engineering drawings and big posters on large size sheets. These are also used to draw the patterns from which microprocessors, memory chips, and other integrated circuits are manufactured. Plotters are used when highest quality and greatest accuracy are required.

There are two basic types of plotters: flat bed plotters and drum type plotters.

➢ **Flatbed Plotter**

A flatbed plotter is also known as Table Plotter. It plots on paper that is spread and fixed over a rectangular flatbed table. The flatbed plotter uses two robotic drawing arms, each of which holds a set of colored ink pens or pencils. The drawing arms move over the stationary paper and draw the graph on the paper. Typically, the plot size is equal to the area of a bed. The plot size may be 20-by-50 feet. It is used in the design of cars, ships, aircrafts, buildings, highways etc. Flatbed plotter is very slow in drawing or printing graphs. The large and complicated drawing can take several hours to print. The main reason of the slow printing is due to the movement mechanical devices. Pen plotter is an example of a flatbed plotter.

➢ **Drum Plotter**

A drum plotter is also known as Roller Plotter. It consists of a drum or roller on which a paper is placed and the drum rotates back and forth to produce the graph on the paper. It also consists of mechanical device known as Robotic Drawing Arm that holds a set of colored ink pens or pencils. The Robotic Drawing Arm moves side to side as the paper are rolled back and forth through the roller. In this way, a perfect graph or map is created on the paper. This work is done under the control of computer. Drum Plotters are used to produce continuous output, such as plotting earthquake activity.

Laser plotter and inkjet plotter are commonly used drum type plotters.

✓ **Advantages of Plotters**

- It allows to work on large sheets of paper.
- It provides exceptional quality resolution.
- It can also print on different materials, like cardboard, plastic, aluminium, plywood, sheet steel, and other flat sheet materials.
- The biggest attributes of the plotter include speed, accuracy, reproducibility, and efficiency.
- In some plotters there is an option of saving different templates and patterns to get rid of the hassle of loading templates and patterns repeatedly. It can easily draw a single pattern over a 1000 times with no degradation.

✓ **Disadvantages of Plotters**

- It takes more space than regular printers,
- These are more expensive than printers on the market.

2.1.2 Computer Speakers

Computer speakers or multimedia speakers, are speakers external to a computer that disable the lower fidelity built-in speaker. They often have a low-power internal amplifier. The standard audio connection is a 3.5 mm (approximately 1/8 inch) stereo phone connector often color-coded lime green (following the PC 99 standard) for computer sound cards. A few use aRCA connector for input. There are also USB speakers which are powered from the 5 volts at 500 milliamps provided by the USB port, allowing about 2.5 watts of output power.

Computer speakers range widely in quality and in price. The computer speakers typically packaged with computer systems are small, plastic, and have mediocre sound quality. Some computer speakers have equalization features such as bass and treble controls. Some computer displays have rather basic speaker's built-in. Laptops come with integrated speakers. Restricted space available in laptops means these speakers usually produce low-quality sound.

For some users, a lead connecting computer sound output to an existing stereo system is practical. This normally yields much better results than small low-cost computer speakers. Computer speakers can also serve as an economy amplifier for MP3 player use for those who wish to not use headphones, although some models of computer speakers have headphone jacks of their own.

2.1.3 Projector

A digital projector is a device which connects to a computer and used to project the video output from the computer onto the wall or projector screen.

A video projector also known as Digital Projector is an image projector that receives a video signal and projects the corresponding image on a projection screen using a lens system. All video projectors use a very bright light to project the image, and most modern ones can correct any curves, blurriness, and other inconsistencies through manual settings. The projector can be portable and placed on a stand or it can be permanently fixed to the ceiling.

Some types of output are text, graphics, tactile, audio, and video. Text consists of characters (letters, numbers, punctuation marks, or any other symbol requiring one byte of computer storage space) that are used to create words, sentences, and paragraphs. Graphics are digital representations of non-text information such as drawings, charts, photographs, and animation (a series of still images in rapid sequence that gives the illusion of motion). Tactile output such as raised line drawings may be useful for some individuals who are blind. Audio is music, speech, or any other sound. Video consists of images played back at speeds to provide the appearance of full motion.

REVIEW QUESTIONS

1. What do you understand by peripheral devices? Give some example of peripheral devices.
2. Explain Input Devices.
3. Explain Output Devices.
4. Explain the Keyboard as input device of a computer. What are its advantages and disadvantages?
5. What is the Mouse? Explain its types, advantages and disadvantages.
6. Define Joystick. How joystick acts as an input device. What are its various advantages and disadvantages?
7. What is a Scanner? Explain its types, advantages and disadvantages.
8. What is a Bar code reader. Explain its types, advantages and disadvantages.
9. Explain the monitor as an output device of a computer, with its advantages and disadvantages.
10. What are the various types of printers available in market?
11. What are the various types of plotters? How they are different from printers?

○○

3

CHAPTER

Computer Memory

LEARNING OUTCOMES

- ☐ Introduction to Computer Memory
- ☐ Cache Memory
- ☐ Primary memory and its types – RAM and ROM
- ☐ Secondary Storage and its types – Magnetic memory and Optical Memory

3.0 INTRODUCTION TO COMPUTER MEMORY

A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in the computer, where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each location or cell has a unique address, which varies from zero to memory size minus one. For example, if the computer has 64k words, then this memory unit has 64 * 1024 = 65536 memory locations. The address of these locations varies from 0 to 65535.

Memory is primarily of three types :

- Cache Memory ✓
- Primary Memory/Main Memory ✓
- Secondary Memory/ Storage Memory ✓

3.1 Cache Memory

Cache memory is a very high-speed semiconductor memory which can speed up the CPU. It acts as a buffer between the CPU and the main memory. It is used to hold those parts of data hold data

and program which are most frequently used by the CPU. The parts of data and programs are transferred from the disk to cache memory by the operating system, from where the CPU can access them. If the CPU finds the required data or instructions in cache memory it doesn't need to access the primary memory (RAM). Thus, it speeds up the system performance

It is extremely expensive therefore manufacturer uses it in low numbers. They are fast and reliable. They are considerably much faster than main memory, the data exchanging time is less as compared to main memory. This is one of the fastest Computer memory used in computer systems. Powerful computer uses more cache memory to speed up the process of information transferring and exchanging.

In other words, Cache **memory** is an electronic component that is found in both the **hardware and software**, it is responsible for storing recurring data to make it easily accessible and faster to requests generated by the system.

Cache memory is taken as a special **buffer** of the memory that all computers have, it performs similar functions as the main memory. One of the most recognized caches are **internet browsers** which maintain temporary downloads made from the internet to have available information for internal system.

Characteristics of Cache Memory

- It allows the quickly access of certain data, readings or files that are in common use, or data that have been recently added as downloads from the Internet.
- It presents an order system according to the importance of the file depending on the requirement of each operating system.
- It allows the processor to improve its performance and the results of the tasks by disposing its information as if it were a continuous use tool.
- It unwinds internal processes of random storage memories (known as RAM).
- Despite being an important part of the operating system, it does not take up much space within the hardware or software.

Advantages of Cache Memory

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.

Disadvantages of Cache Memory

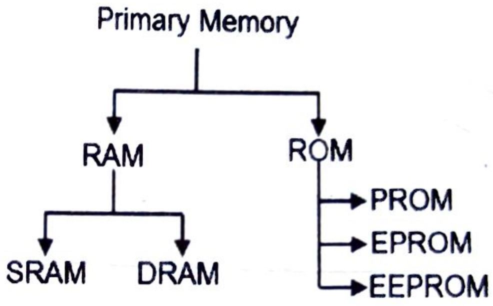
- Cache memory has limited capacity.
- It is very expensive.

3.2 Primary Memory (Main Memory)

Primary or Main Memory is additionally called as "Internal Memory" or "Semiconductor Memory" as it is generally made up of semiconductor device. This is likewise a temporary memory which holds or saves data and information temporarily, as when there is a power failure or no power the data or information is lost. They work or hold only on the present data which is being used and utilized by a computer system, i.e. Primary memory holds only those data and instructions on which the computer is currently working. The semiconductor memory is faster, smaller, lighter and they consume less power compared to secondary storage. They have a limited capacity, as well as they are very costly and can store only a couple of bytes of data.

They are essential memories to a computer as if they removed from a computer it fails to start or boot normally. Each and every computer needs primary memory to work properly. The capacity of primary memory is calculated in MB (Mega-Bytes) and GB (Gega-Bytes). Nowadays, these come in huge capacities ranges from 2 GB to 16 GB.

It is divided into two subcategories RAM and ROM.



✓ **Characteristics of Main Memory**

- These are semiconductor memories.
- It is known as the main memory.
- Usually volatile memory.
- Data is lost in case power is switched off.
- It is the working memory of the computer.
- Faster than secondary memories.
- A computer cannot run without the primary memory.

3.2.1 RAM (Random Access Memory)

The acronym RAM stems from the fact that data stored in random access memory can be accessed – as the name suggests – in any random order. Or, put another way, any random bit of data can be accessed just as quickly as any other bit.

The most important things to understand about RAM are that RAM memory is very fast, it can be written to as well as read, it is volatile (so all data stored in RAM memory is lost when it loses power) and, finally, it is very expensive compared to all types of secondary memory in terms of cost per gigabyte. It is because of the relative high cost of RAM compared to secondary memory types that most computer systems use both primary and secondary memory.

In other words, RAM is the internal memory of the CPU for storing data, program, and program result. It is a read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased.

Data that is required for imminent processing is moved to RAM where it can be accessed and modified very quickly, so that the CPU is not kept waiting. When the data is no longer required it is shunted out to slower but cheaper secondary memory, and the RAM space that has been freed up is filled with the next chunk of data that is about to be used.

Access time in RAM is independent of the address, that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time. Data in the RAM can be accessed randomly but it is very expensive.

RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure. Hence, a backup Uninterruptible Power System (UPS) is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold.

RAM is of two types :

- Static RAM (SRAM)
- Dynamic RAM (DRAM)

Static RAM

- Static RAM (SRAM)

The word **static** indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM chips use a matrix of 6-transistors and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not be refreshed on a regular basis.

There is extra space in the matrix, hence SRAM uses more chips than DRAM for the same amount of storage space, making the manufacturing costs higher. SRAM is thus used as cache memory and has very fast access.

✓ Characteristic of Static RAM

- Long life
- No need to refresh
- Faster
- Used as cache memory
- Large size
- Expensive
- High power consumption

Dynamic RAM (DRAM)

DRAM, unlike SRAM, must be continually refreshed in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory as it is cheap and small. All DRAMs are made up of memory cells, which are composed of one capacitor and one transistor.

✓ Characteristics of Dynamic RAM

- Short data lifetime
- Needs to be refreshed continuously
- Slower as compared to SRAM
- Used as RAM

- Smaller in size
- Less expensive
- Less power consumption

✓ Difference between SRAM and DRAM

BASIS OF COMPARISON	DRAM	SRAM
Cost	Cheaper	More expensive
Performance	Slower: Off-chip memory with longer access time.	On-chip memory with minimal access time; can run at the speed of the host microprocessor
Use case	Main memory	Level 1 and Level 2 microprocessor caches
Density	Less density per cell (1 transistor per chip) but can pack more cells into space	Denser (6 transistors per chip) but can fit fewer cells into space
Power	Generally higher: Capacitors leak power thanks to imperfect insulation, requiring regular power refreshes.	Generally lower: No charge leakage since it changes direction of current through switches instead of leaking power through the capacitor. However, this depends on the application environment and SRAM can consume as much or more power as DRAM.
Storage capacity	Larger: Connects directly to CPU bus, volatile storage measured in GBs	Smaller: Acts as cache; storage measured in MBs
Volatility	Volatile: Must have active power supply plus frequent charges while active.	Volatile: Does not require additional charges while it is receiving power, but eventually loses data without it.
Physical placement	Motherboard	Processors or between processor and main memory

3.2.2 ROM (Read Only Memory)

ROM is the memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM stores such instructions that are required to start a computer. This operation is referred to as bootstrap. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.

The various types of ROMs and their characteristics are as follows:

- **MROM (Masked ROM)**

The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions. These kind of ROMs are known as masked ROMs, which are inexpensive.

- **PROM (Programmable Read Only Memory)**

PROM is read-only memory that can be modified only once by a user. The user buys a blank PROM and enters the desired contents using a PROM program. Inside the PROM chip, there are small fuses which are burnt open during programming. It can be programmed only once and is not erasable.

- **EPROM(Erasable and Programmable Read Only Memory)**

EPROM can be erased by exposing it to ultra-violet light for a duration of up to 40 minutes. Usually, an EPROM eraser achieves this function. During programming, an electrical charge is trapped in an insulated gate region. The charge is retained for more than 10 years because the charge has no leakage path. For erasing this charge, ultra-violet light is passed through a quartz crystal window (lid). This exposure to ultra-violet light dissipates the charge. During normal use, the quartz lid is sealed with a sticker.

- **EEPROM (Electrically Erasable and Programmable Read Only Memory)**

EEPROM is programmed and erased electrically. It can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (millisecond). In EEPROM, any location can be selectively erased and programmed. EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of reprogramming is flexible but slow.

✓ Advantages of ROM

- Non-volatile in nature
- Cannot be accidentally changed
- Cheaper than RAMs
- Easy to test
- More reliable than RAMs
- Static and do not require refreshing
- Contents are always known and can be verified

✓ Difference between RAM and ROM

BASIS FOR COMPARISON	RAM	ROM
Basic	It is a read-write memory.	It is read only memory.
Use	Used to store the data that has to be currently processed by CPU temporarily.	It stores the instructions required during bootstrap of the computer.
Volatility	It is a volatile memory.	It is a non-volatile memory.
Stands for	Random Access Memory.	Read Only Memory.
Modification	Data in ROM can be modified.	Data in ROM can not be modified.
Capacity	RAM sizes from 64 MB to 4GB.	ROM is comparatively smaller than RAM.
Accessibility	RAM can be directly accessed by the processor	ROM can't be directly accessed by the processor since it is transferred into RAM where it is executed by the processor
Hardware structure	RAM is in the form of chip	ROM is generally optical drivers mad
Cost	RAM is a costlier memory.	ROM is comparatively cheaper than RAM.
CPU Interaction	The CPU can access the data stored on it.	The CPU can not access the data stored on it. In order to do so, the data is first copied to the RAM.
Speed	It is a high-speed memory.	It is much slower than the RAM.
Type	Types of RAM are static RAM and dynamic RAM.	Types of ROM are PROM, EPROM, EEPROM.

3.3 SECONDARY MEMORY

main → CPU

This type of memory is also known as external memory, Storage memory, Auxiliary memory, Backup memoryor non-volatile memory. It is slower than the main memory. These are used for storing data/information permanently. CPU directly does not access these memories, instead they are accessed via input-output routines. The contents of secondary memories are first transferred to the main memory, and then the CPU can access it. It is also used for carrying data from one computer to another.For example, disk, CD-ROM, DVD, etc.

✓ Characteristics of Secondary Memory

- These are magnetic and optical memories.
- It is known as the backup memory.
- It is a non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without the secondary memory.
- Slower than primary memories.

It is very common for new computer users to be confused by what parts in the computer are memory. Although both the hard drive and RAM are memory, it is more appropriate to refer to RAM as "memory" or "primary memory" and a hard drive as "storage" or "secondary storage."

Types of secondary memory areMagnetic Memory and Optical Memory

1. Magnetic Memory

Magnetic memory uses the property of magnet for storing data. It is in use since first generations of computer. It contains data storing surface coated by magnetic oxide. Magnetic memory is further divided as:

- **Magnetic Drum**

Magnetic drum contains a metallic drum coated by magnetic oxide on the outer surface of the drum, data is stored in this surface. It was in use in first and second generations of computer.

- **Magnetic tape**

Magnetic tape contains thin plastic ribbon, only one side of the ribbon is used for storing data. The data storing side is coated by magnetic oxide. It is a sequential access memory. So, the data read/write speed is slower. It is mainly used for storing audio, video and back-up data. It is highly reliable. It requires magnetic tape drive for reading and writing data. It has the storage capacity of 100MB-200GB. The width of the ribbon also varies from 4mm-1inch.

- **Magnetic disk**

Magnetic disk contains a circular disc made of metal or plastic. Both side of the disc is usually used for storing data. The disc is coated by magnetic oxide. The disc is divided into multiple concentric circles known as track. Tracks are further divided into small area known as sectors. Data are stored in sectors.

Example : Hard disk, floppy disk etc.

Hard Disk : Another form of auxiliary storage is a hard disk. It is used as main storage device of the computer. It uses 2-4 metallic disk (platter). The disk is usually made of aluminium. Both sides of the disk are used for storing data except the upper side of the uppermost disk and lower side of the lowermost disk. The data storing surface is coated by magnetic oxide. Each data storing surface contains separate read/write head. During data read/write process platter rotates at the rate of 3600-15000rpm. Hard disk is also known as hard drive because both data storing disk and data read/write components are combined together. It has the storage capacity of few mega bytes to tera byte.

Floppy Disk : These are small removable disks that are plastic coated with magnetic recording material. Floppy disks are typically 3.5? in size (diameter) and can hold 1.44 MB of data. This portable storage device is a rewritable media and can be reused a number of times. Floppy disks are commonly used to move files between different computers. It requires floppy drive for its operation. It is not reliable as hard disk because the data storing surface is exposed. So, it may be affected by dust particles and magnetic field and this is the main disadvantage of floppy disk.

2. Optical Memory

Optical memory uses light beam for its operation. It is developed in fourth generation of computer. It is mainly used for storing audio/video, backup as well as for carrying data. It requires optical drive for its operation. Its read/write speed is slower compared to hard disk and flash memories.

Example : CD, DVD, BD

- **CD** : It stands for Compact Disk. It has storage capacity of 700 MB or approximately 90 minutes of standard audio. CD contains hard circular plastic, single side of this plastic is coated by aluminium alloy. This alloy stores data. It is protected by additional thin plastic covering. CD required CD drive for its operation. Types of CD are:
  - o **CD-R** : It is a blank CD in which data can be stored once. After storing data it is converted into CD-ROM.
  - o **CD-ROM** : It cannot be erased or updated.
  - o **CD-RW** : It can be erased and used for multiple times.
- **DVD** : It stands for Digital Versatile Disk. It has the storage capacity of 4.7GB to 17GB. Its shape and size is similar to CD but the difference in storage capacity is due to different chemical component and data is compressed before storing. It requires DVD drive for its operation. Read/write speed of DVD is slower than that of CD. Types of DVD are:
  - o DVD-R
  - o DVD-ROM
  - o DVD-RW
- **BD** : It stands for Bluray disk. It has the storage capacity of 25GB-50GB. It requires BD drive for its operation. Its shape and size aresimilar to CD and DVD. Types of BD are:
  - o BD-R
  - o BD-ROM
  - o BD-RW

KB
MB
GB
TB
PB
Hexa
Zetta
Yotta

REVIEW QUESTIONS

1. What is Computer Memory? Explain its various types.
2. What is Cache Memory? Explain in detail?
3. Define Primary Memory. What are the various types of primary memory.
4. Differentiate between RAM and ROM.
5. Distinguish between SRAM and DRAM.
6. Explain in detail the secondary memory and its various forms.

4

CHAPTER

Computer Software

LEARNING OUTCOMES

- ☐ What is computer Software.
- ☐ Types of Computer Software.
- ☐ System and Application Software.
- ☐ Introduction to Compiler, Assembler, Linker, Loader and Interpreter.

4.0 INTRODUCTION TO COMPUTER SOFTWARE

↑ the capability of hardware / machine

Software is a set of programs, which is designed to perform a well-defined function. A program is a sequence of instructions written to solve a problem. In other words, Software is a set of instructions, data or programs used to operate computers and execute specific tasks. Opposite of hardware, which describes the physical aspects of a computer, software is a generic term used to refer to applications, scripts and programs that run on a device. Software can also be thought of as the variable part of a computer and hardware the invariable part. Without software, most computers would be useless. For example, without the Internet browsersoftware, one could not surf the Internet. Without an operating system, the browser could not run on the computer.

A computer system cannot do anything its own, it must be instructed to do a desired job. Hence, it is necessary to specify a sequence of instructions that a computer must perform to solve a problem. Such a sequence of instructions written in a language that can be understood by a computer is called a computer program. It is the program that controls the activity of processing by the computer; and the computer performs precisely what the program wants it to do. The term software refers to the set of computer programs, procedures and associated documents. Precisely, software means a collection of programs whose objective is to enhance the u

capabilities of the hardware machine. Fig 4.1 shows the relationship between hardware, software and user.

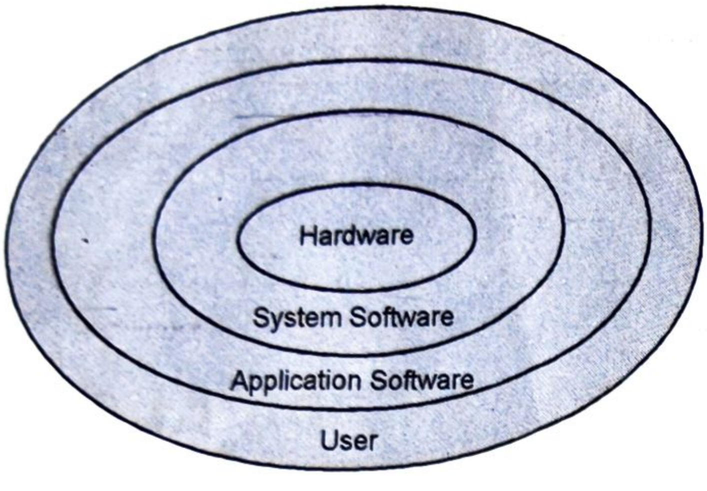


Figure 4.1 : Relation between Hardware, Software and User

Software can be purchased or acquired in the following ways :

- *Shareware-usually distributed on a free or trial basis with the intention of sale when the period is over.*
- *Liteware-a type of shareware with some capabilities disabled until the full version is purchased.* – restriction like modify, copyri . sellig etc.
- *Freeware-can be downloaded for free but with copyright restrictions.*
- *Public domain software-can be downloaded for free without restrictions.*
- *Open source- a type of software where the source code is furnished and users agree not to limit the distribution of improvements.*

Today, much of the purchased software, shareware and freeware is directly downloaded over the Internet. In these cases, software can be found on specific vendor websites or application service providers. However, software can also be packaged on CD-ROMs or diskettes and sold physically to a consumer.

4.1 TYPES OF COMPUTER SOFTWARE

There are two types of software (shown in Figure 4.2)

- **System Software** : System software consists of the background programs (Namely, the operating system and utility programs) that controls a computer system and allow the use of the computer. These programs enable the computer to boot, to launch application programs, and to facilitate important jobs, such as transferring file from one storage medium to another, configuring the computer system to work with the hardware connected to it, managing files on the hard drive ,and protecting the computer system from unauthorized use.

background pro
- OS
- utility prog.

control compute & allows use

system utility – improved functionality
* Antivirus
backup
* Disk tool.
disk cleaner.
disk fragmenters
* *

Application Software : Application software includes all the programs that allow a user to perform specific tasks on a computer, such as writing letter, preparing an invoice, viewing a web page, listening to a downloaded music file, checking the inventory of a particular product, playing a game, preparing financial statement, designing a home, and so forth.

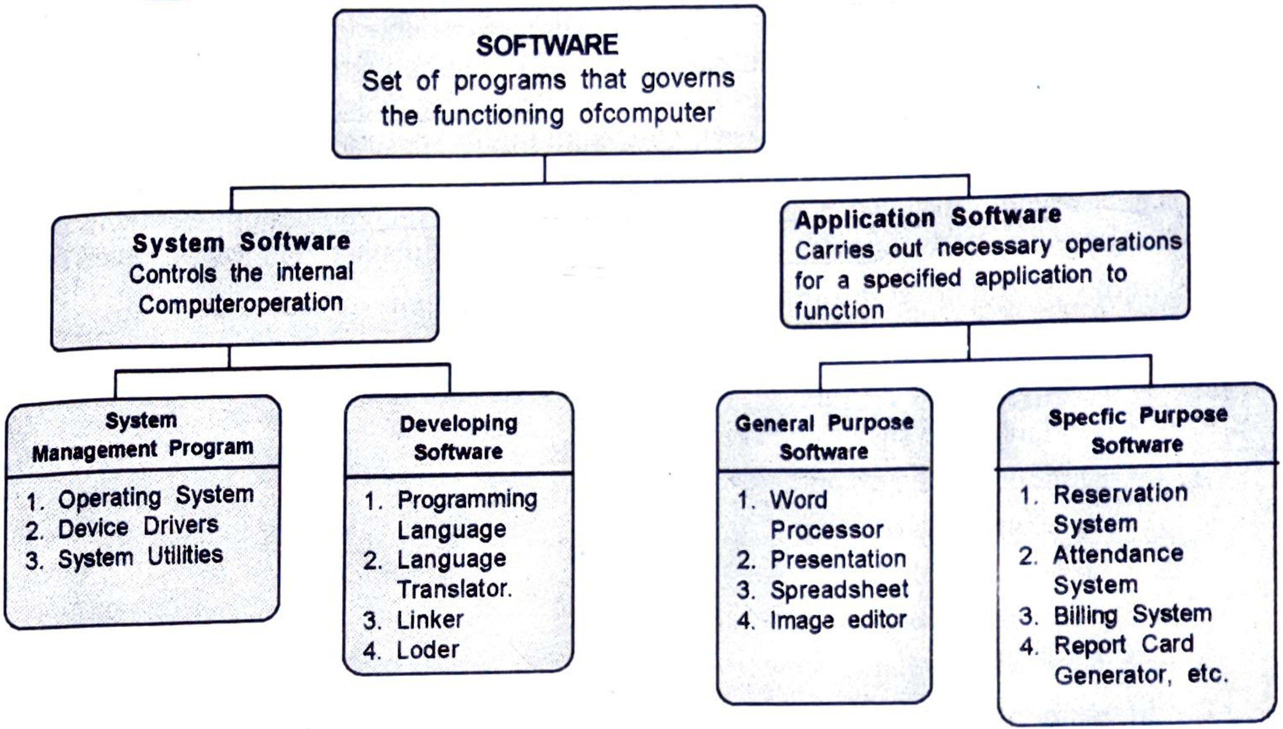

SOFTWARE
Set of programs that governs the functioning ofcomputer
System Software
Controls the internal Computeroperation
Application Software
Carries out necessary operations for a specified application to function
System Management Program
1. Operating System
2. Device Drivers
3. System Utilities
Developing Software
1. Programming Language
2. Language Translator.
3. Linker
4. Loder
General Purpose Software
1. Word Processor
2. Presentation
3. Spreadsheet
4. Image editor
Specfic Purpose Software
1. Reservation System
2. Attendance System
3. Billing System
4. Report Card Generator, etc.

Figure 4.2: Classification of Computer Software

4.2 SYSTEM SOFTWARE

The system software is a collection of programs designed to operate, control, and extend the processing capabilities of the computer itself. System software is generally prepared by the computer manufacturers. These software products comprise of programs written in low-level languages and therefore it is called "low-level" software, which interact with the hardware at a very basic level. System software serves as the interface between the hardware and the end users.

System software refers to the files and programs that make up the computer's operating system. System files include libraries of functions, system services, drivers for printers and other hardware, system preferences, and other configuration files. The programs that are part of the system software include assemblers, compilers, file management tools, system utilites, and debuggers.

The system software is installed on one's computer when one install the operating system. The software can be updated by running programs such as "Windows Update" for Windows or "Software Update" for Mac OS X. System software is not meant to be run by the end user. For example, while people might use the Web browser every day, but don't have much use for an assembler program.

Win - Mic
ios - Apple
Linux

System software is often invisible to users because it is what gets the computer booted up so that users can do interesting things. Yet without this software, the computer would not run. For example, a printer hooked to a computer requires a certain kind of software called a "driver." Anyone sending a document to the printer would not be aware of this software unless it was not installed, in which case the document wouldn't print. Even hardware that is part of the computer, such as a trackpad on a laptop, requires a driver. Another example of system software would be the programs used to manage a computer, such as installing or removing software and the programs that create the desktop environment. There are three major brands of system software in use and many smaller brands as well. One of the most well known is Windows, which is published by Microsoft and often installed on computers before a customer buys them. Another brand is iOS, which is installed on Apple computers. A third well-known group of system software is Linux. There are many different versions of Linux, tailored made to different people's needs.

✓ **Some of the most prominent features of a system software are —**

- Close to the system
- Fast in speed
- Difficult to design
- Difficult to understand
- Less interactive
- Smaller in size
- Difficult to manipulate
- Generally written in low-level language

✓ **In general, system software performs the following functions:**

- It provides platform to develop and execute application program such as Word, Excel.
- It monitors and controls the effective use of hardware resources such as memory, CPU, I/O devices etc.
- It establishes the communication between I/O devices.

✓ **System Software can be classified as**

(a) **System management program** : System software for the management and functionality of computer relates to the functioning of different components of the computer like processor, input and output devices etc. System software is required for managing the operation performed by the components of computer and the devices attached to the computer. It provides support for various services, as requested by the application software. Operating system device, drivers and software utilities constitute the system software for management of computer and its resources and their functions are as follows:

- **Operating System** : Harnesses communication between hardware, system programs, and other applications.
- **Device Driver** : Enables device communication with the OS and other programs.
- **Utility** : Ensures optimum functionality of devices and applications.

(b) **Developing software** : System software for the development of application software provides services required for the development and execution of application software. System software provides the software tools required for the development of application software. The programming language software, translator, software, loader, and linker are also categorized as system software, and are required for the application software development.

4.2.1 Operating System (OS)

The operating system is a type of system software kernel that sits between computer hardware and end user. It is installed first on a computer to allow devices and applications to be identified and therefore functional.

System software is the first layer of software to be loaded into memory every time a computer is powered up.

Suppose a user wants to write and print a report to an attached printer. A word processing application is required to accomplish this task. Data input is done using a keyboard or other input devices and then displayed on the monitor. The prepared data is then sent to the printer.

For the word processor, keyboard, and printer to accomplish this task, they must work with the OS, which controls input and output functions, memory management, and printer spooling.

Today, the user interacts with the operating system through the graphical user interface (GUI) on a monitor or touchscreen interface. The desktop in modern OSs is a graphical workspace, which contains menus, icons, and apps that are manipulated by the user through a mouse-driven cursor or the touch of a finger. The disk operating system (DOS) was a popular interface used in the 1980s.Operating system is discussed later in detail in Chapter 5.

4.2.2 Device Drivers

Driver software, more commonly known as a driver, a device driver or hardware driver, is a type of system software which brings computer devices and peripherals to life. Drivers make it possible for all connected components and external add-ons perform their intended tasks and as directed by the OS. Without drivers, the OS would not assign any duties. In other words, device driver is a group of files that enable one or more hardware devices to communicate with the computer's operating system. Without drivers, the computer would not be able to send and receive data correctly to hardware devices, such as a printer. If the appropriate driver is not installed, the device may not function properly, if at all. For Microsoft Windows users, a driver conflict or an error can be seen in the Device Manager. If problems or conflicts are encountered with a driver, the computer manufacturer or hardware manufacturer will release a driver update to fix the problems.

Various devices which require driv-ers are Mouse, Keyboard, Soundcard, Display card, Network card, Printer.

When buying an operating system, many device drivers are built into the product. However, if a user later buys a new type of device that the operating system did not anticipate, the new device driver will have to be installed. A device driver essentially allows smooth communication between a connected hardware device and the operating system (OS). Usually, the operating system ships with drivers for most devices already in the market. By default, input devices such as the mouse and keyboard will have their drivers installed. They may never require third-party installations. For example: Dell laptops come with the Dell drivers and Utilities CD (shown in Figure 4.3)

If a device is newer than the operating system, the user may have to download drivers from manufacturer websites or alternative sources.

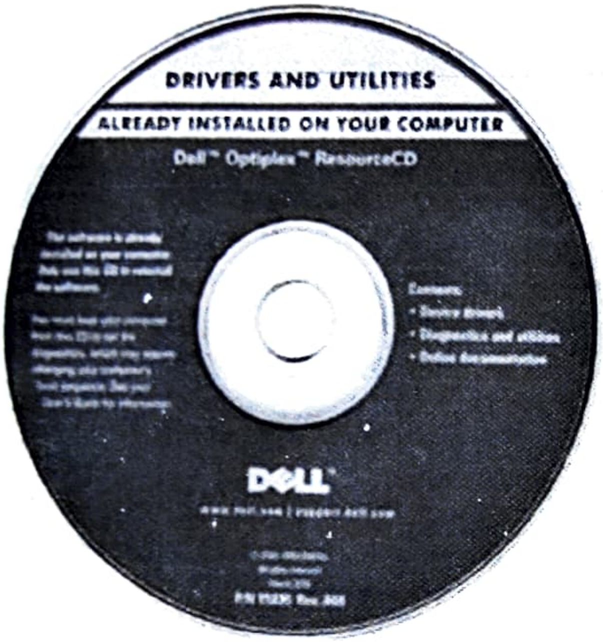

DRIVERS AND UTILITIES
ALREADY INSTALLED ON YOUR COMPUTER
Dell™ Optiplex™ ResourceCD
DELL

Figure 4.3 : Dell drivers and Utilities CD

4.2.3 System Utilities

System utilities are the software functions that helps to manage, maintain and control computer resources. Operating systems typically contain the necessary tools for this, but separate utility programs can provide improved functionality. Utility software is often somewhat technical and targeted at users with a solid knowledge of computers. If one use a computer mostly for e-mail, some Internet browsing and typing up a report, these utilitiesmay not have much needed. However, if one is an avid computer user, these utilities can help make sure that the computer stays in tip-top shape.

Examples of utility programs are antivirus software, backup software and disk tools.

- **Antivirus software** : It helps to protect a computer system from viruses and other harmful programs. A computer virus is a computer program that can cause damage to a computer's software, hardware or data. It is referred to as a virus because it has the capability to replicate itself and hide inside other computer files.

  One of the most common ways to get a virus is to download a file from the Internet. Antivirus software scans the online activity to make sure that infected filesare not downloading. New viruses are coming out all the time, so antivirus software needs to be updated very frequently.

- **Backup software** : It helps in the creation of a backup of the files on the computer. Most computer systems use a hard disk drive for storage. While these are generally very robust, they can fail or crash, resulting in costly data loss. Backup software helps to copy the most important files to another storage device, such as an external hard disk. One can also make an exact copy of the hard disk.

  Increasingly, backup software uses cloud storage to create backups. This typically means that fees need to be paid to use the storage space of a third party and use their backup software to manage which files are going to be backed up.

- **Disk tools** : It include a range of different tools to manage hard disk drives and other storage devices. This includes utilities to scan the hard disks for any potential problems. Example of Disk tools include disk cleaners, disk defragmenters, system restore etc.
  - Disk Cleanup is a function that comes with all versions of Windows Operating Systems. Disk Cleanup allows to scan the entire hard drive to search for extra room by deleting any un-necessary files such as temporary files from the Internet and cookies that are downloaded when one visit webpages. Not only does Disk Cleanup allow to delete simple files from the Internet, but it also allows to delete Restore Points, uninstall programs, remove Windows components, and compress old files all in the click of a mouse.
  - The Disk Defragmenter is another tool that comes with Windows and is used for many different solutions. The main function of the Disk Defragmenter is to reassemble fragmented files. Whenever a file is modified in any way, the computer stores the file in broken pieces across the hard drive rather than putting the whole file in one spot. This can lead to system malfunction and poor performance because the computer must search for all the pieces of a specific file before it can display it. The Disk Defragmenter searches for all pieces of every file on the hard drive and reassembles the files into a specific location. This increases the speed at which files are displayed and results in less delays when opening files or programs.
  - System Restore is a function that comes with Windows that allows to return the computer to an earlier time in which it had not encountered an error. System Restore is great for fixing problems that a virus has caused after the use of antivirus software to rid the computer of the malware. System Restore allows to manually set Restore Points on a calendar and automatically creates Restore Points on a regular basis as well as right before the computer goes through any major change such as installing a new program.

Disk tools are important because a failure of a hard disk drive can have disastrous consequences. Keeping disks running efficiently is an important part of overall computer maintenance.

4.2.4 Programming Language

A set of words, symbols and codes used to write programs is called programming language. There are different types of computer languages called high level languages available such as C++, Java, Visual Basic, etc. The two types of programming languages are low level and high-level languages.

(i) **Low Level Programming Languages** : A Language, which is near to the computer hardware and easily understandable by computer is a low-level language. Machine language and assembly language are low level programming language.

- ✓ **Machine Language**: Machine language is the first-generation language developed to communicate with the computer. In this language, instructions are written in machine code i.e. binary form (0 and 1), a native language of machine easily understandable to the computer. The execution of the program is very fast. Computer system can recognize electric signals so here 0 stands for turning off electric pulse and 1 stands for turning on electric pulse. There is no need of compiler and interpreter in case of machine language as the Computer directly can understand its own language. Certain limitations of machine language are that it is difficult to learn, understand and modify. It requires a good understanding and knowledge about computer hardware and very difficult to remove errors.

- ✓ **Assembly Language** : Assembly language is a low-level language. In assembly language, symbols are used instead of binary code. These symbols are easy to remember. For example, ADD instruction is used to add two numbers. Assembly language is also known as second generation language.

(ii) **High Level Programming Languages** : High level languages are easy to understand because they are written in English words like Print, Display, Write etc. These languages are easy to modify, remove errors and machine independent. The various high-level languages are COBOL, BASIC, C, C++, JAVA, Visual Basic.

[*Note : Programming Language is discussed in detail in Chapter* 6]

4.2.5 Language Translators

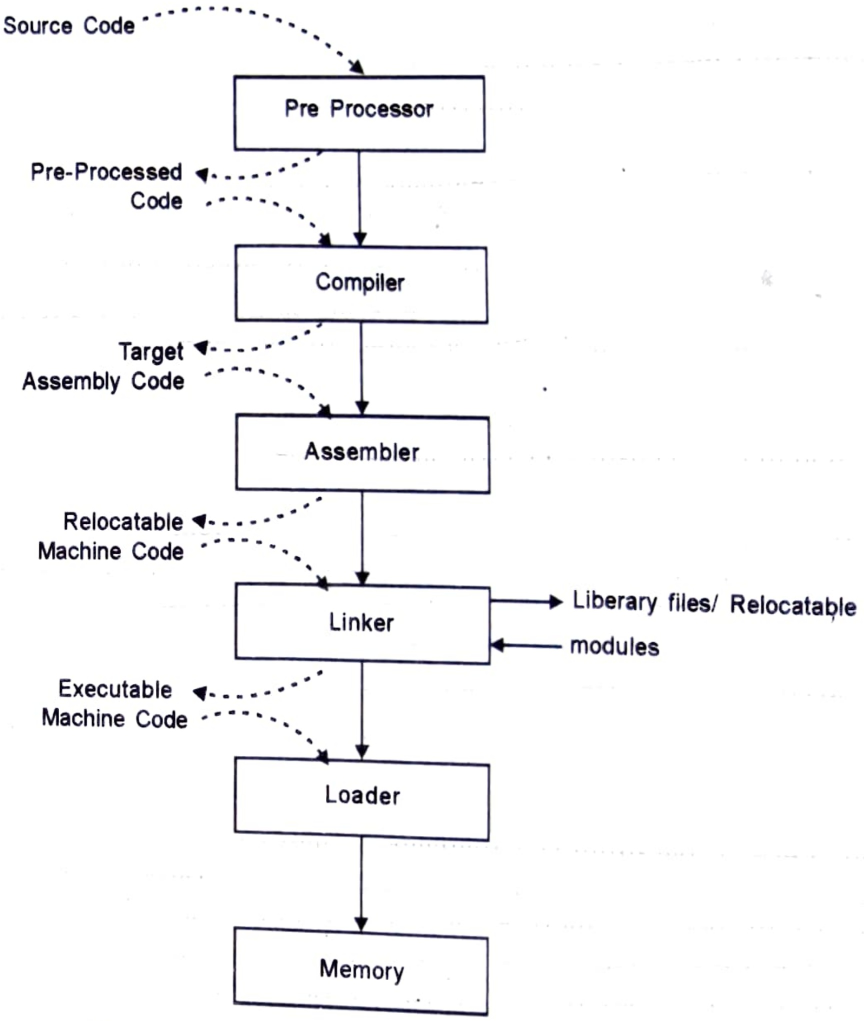

Source Code
Pre Processor
Pre-Processed Code
Compiler
Target Assembly Code
Assembler
Relocatable Machine Code
Linker
Liberary files/ Relocatable modules
Executable Machine Code
Loader
Memory

Figure 4.4: Phases in Language Translator

4.2.5.1 Compiler

A compiler is system software (a set of a computer program) that converts source code written in a programming language (source language, usually HLL) into another computer language (target language). It processes every statement written in a particular programming language and turns them to machine language.

The process of converting high-level programming language into lower level language (e.g., assembly language or machine code) is known as compilation.

After writing the program the programmer runs the code in an appropriate language compiler specifying the name of the file that contains the source statements.

When executing or running the program, the first task of the compiler is to parse all the language statement syntactically one after another and then build the .obj file and finally build the executable file (which is possible if the final code is correct). The output of the compiled code is referred to as the object code or sometimes called the object module.

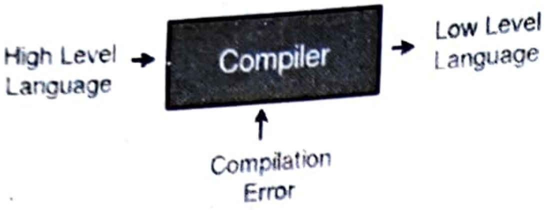

High Level Language
Compiler
Low Level Language
Compilation Error

Figure 4.5: Task of Compiler

✓ Phases of a Compiler

There are two phases of compilers, namely Analysis phase and Synthesis phase. Analysis phase creates an intermediate representation from the given source code. Synthesis phase creates an equivalent target program from the intermediate representation.

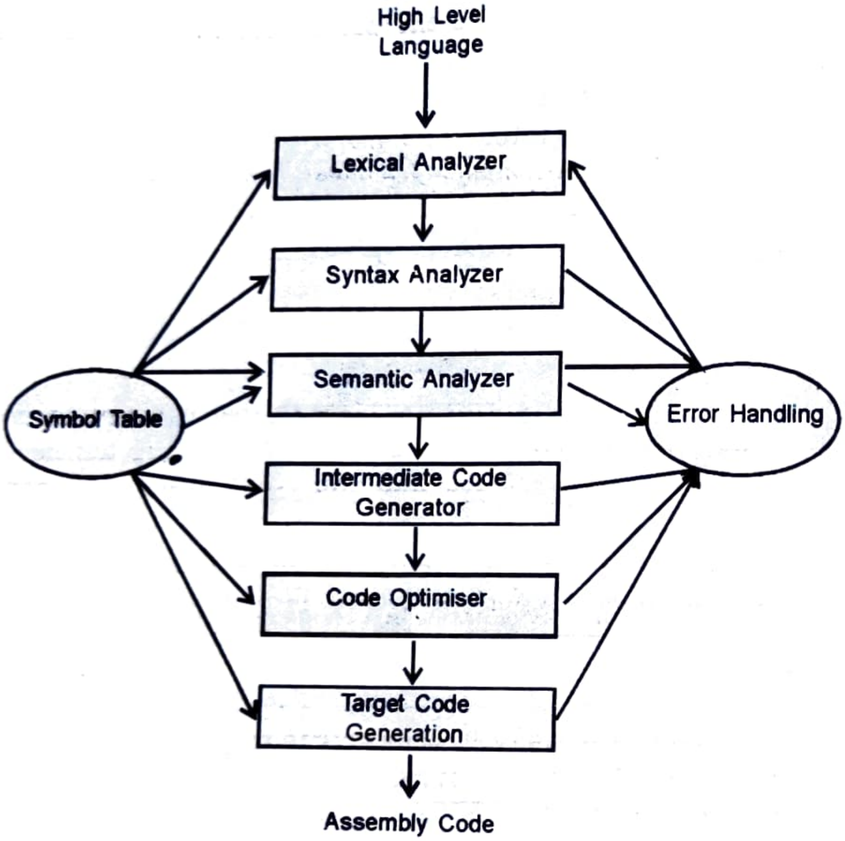

High Level Language
Lexical Analyzer
Syntax Analyzer
Semantic Analyzer
Intermediate Code Generator
Code Optimiser
Target Code Generation
Assembly Code
Symbol Table
Error Handling

Figure 4.6 : Phases of a Compiler

Symbol Table – It is a data structure being used and maintained by the compiler, consists all the identifier's name along with their types. It helps the compiler to function smoothly by finding the identifiers quickly.

The compiler has two modules namely front end and back end. Front-end constitutes of the Lexical analyzer, semantic analyzer, syntax analyzer and intermediate code generator. And the rest are assembled to form the back end.

- **Lexical Analyzer** – It reads the program and converts it into tokens. It converts a stream of lexemes into a stream of tokens. Tokens are defined by regular expressions which are understood by the lexical analyzer. It also removes white-spaces and comments.
- Syntax Analyzer – It is sometimes called as parser. It constructs the parse tree. It takes all the tokens one by one and uses Context Free Grammar to construct the parse tree.

✓ Why Grammar?

The rules of programming can be entirely represented in some few productions. Using these productions we can represent what the program actually is. The input has to be checked whether it is in the desired format or not.

Syntax error can be detected at this level if the input is not in accordance with the grammar.

- **Semantic Analyzer** – It verifies the parse tree, whether it's meaningful or not. It furthermore produces a verified parse tree.It also does type checking, Label checking and Flow control checking.
- **Intermediate Code Generator** – It generates intermediate code, that is a form which can be readily executed by machine We have many popular intermediate codes. Example – Three address code etc. Intermediate code is converted to machine language using the last two phases which are platform dependent.

Till intermediate code, it is same for every compiler out there, but after that, it depends on the platform. To build a new compiler we don't need to build it from scratch. We can take the intermediate code from the already existing compiler and build the last two parts.

- **Code Optimizer** – It transforms the code so that it consumes fewer resources and produces more speed. The meaning of the code being transformed is not altered. Optimisation can be categorized into two types: machine dependent and machine independent.
- **Target Code Generator** – The main purpose of Target Code generator is to write a code that the machine can understand and also register allocation, instruction selection etc. The output is dependent on the type of assembler. This is the final stage of compilation.

Note : A compiler can translate only those source programs which have been written in that language for which the compiler is meant for. For example, COBOL compiler will not compile source code written in FORTRAN language

4.2.5.2 Assembler

Assembler is a program for converting instructions written in low-level assembly code into relocatable machine code. In other words, Programs written in an assembly language must be translated into binary representation of instruction before they can be executed by the processor. An Assembler (Assembly Program) translates the assembly instruction into the machine code of the computer. A program of instructions written in machine language is called a source program. After this source program has been converted into machine code by an assembler, it is referred to as an object program.

An assembler which runs on a computer for which it produces object codes (machine codes) is called a self-assembler (or resident assembler). Assembler generates instructions by evaluating the mnemonics (symbols) in operation field and find the value of symbol and literals to produce machine code. Now, if assembler do all this work in one scan then it is called single pass self-assembler, otherwise if it does in multiple scans then called multiple pass self-assembler.

✓ Cross Assemblers

A less powerful and cheaper computer may not have enough software and hardware facilities for program development. In such a situation, a faster and more powerful computer can be used for pro-gram development. The programs so developed are to be run on smaller computers. For such program development, a cross assembler is required. A cross assembler is an assembler that runs on a computer other than that for which it produces machine codes.

These are further classified as follows :

(*a*) **One-pass Assemblers** : It is an assembler which reads the assembly language programs only once. Such an assembler must be equipped with some means to assign addresses to the labels used in the assembly language program.

(*b*) **Two-pass Assemblers** : It is an assembler which goes through the assembly language program twice. On the first pass, the assembler reads the assembly language program and collects all labels. It assigns addresses to the labels counting their position from the starting address. On the second pass, the assembler produces the machine code for each instruction and assigns addresses to each instruction

4.2.5.3 Linker

In high level languages, some built in header files or libraries are stored. These libraries are predefined, and these contain basic functions which are essential for executing the program. These functions are linked to the libraries by a program called Linker. If linker does not find a library of a function, then it informs to compiler and then compiler generates an error. The compiler automatically invokes the linker as the last step in compiling a program. Not built in libraries, it also links the user defined functions to the user defined libraries. Usually a longer program is divided into smaller subprograms called modules. And these modules must be combined into one single executable code program to execute the program. The process of combining the modules is done by the linker.

Linker is a program in a system which helps to link the object modules of program into a single object file. It performs the process of linking. Linker are also called link editors. Linking is process of collecting and maintaining piece of code and data into a single file. Linker also link a module into system library. It takes object modules from assembler as input and forms an executable file as output for loader.

Linking is performed at both compile time, when the source code is translated into machine code and load time, when the program is loaded into memory by the loader.

In gist, the primary functions of Linker are:

- To links and merges various object files together in order to make an executable file. All these files might have been compiled by separate assembler.

- To search and locate referenced module/routines in a program and to determine the memory location where these codes will be loaded making the program instruction to have absolute reference.

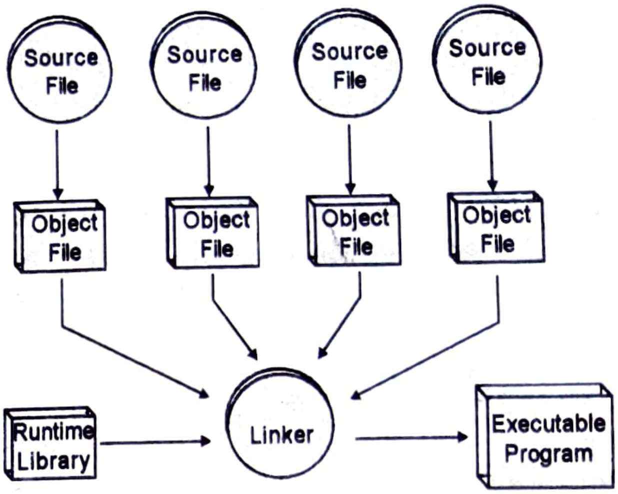


Figure 4.7: Task of Linker

4.2.5.4 Loader

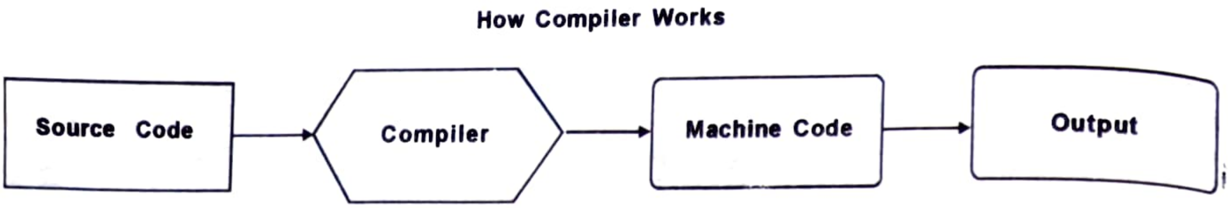
Loader is a program that loads machine codes of a program into the system memory. In Computing, a loader is the part of an Operating System that is responsible for loading programs. It is one of the essential stages in the process of starting a program. Because it places programs into memory and prepares them for execution. Loading a program involves reading the contents of executable file into memory. Once loading is complete, the operating system starts the program by passing control to the loaded program code. All operating systems that support program loading have loaders. In many operating systems the loader is permanently resident in memory.

In gist, the basic functions of Loader are:

- Loader is a part of operating system and is responsible for loading executable files into memory and execute them.
- It calculates the size of a program (instructions and data) and create memory space for it. It initializes various registers to initiate execution.

4.2.5.5 Interpreter

Interpreter is a program that executes instructions written in a high-level language. There are two ways to run programs written in a high-level language. The most common is to compile the program; the other method is to pass the program through an interpreter. This indicates that both compiler and interpreters do the same job which is converting higher level programming language to machine code. However, a compiler will convert the code into machine code (create an exe) before program run. Interpreters convert code into machine code when the program is run. Also, an interpreter translates high-level instructions into an intermediate form, which it then executes. In contrast, a compiler translates high-level instructions directly into machine language.


How Compiler Works

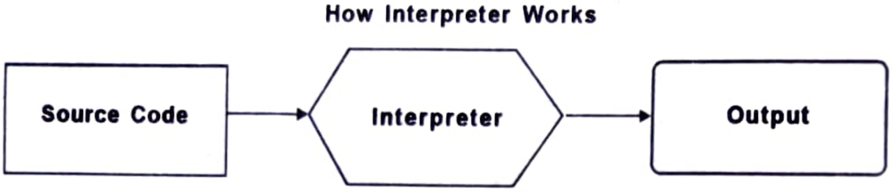

How Interpreter Works

Figure 4.8: Difference in working of Compiler and Interpreter

✓ Difference between compiler and Interpreter

basis of Comparison	Compiler	Interpreter
Translation	The entire program is translated as a whole	The program is translated line by line
Involvement in execution	Not involved in execution	Involved in execution
	Less complex in nature	More complex in nature
Complexity	It takes large amount of time to analyse the source code but the overall execution time is comparatively faster.	It takes less amount of time to analyse the source code but the overall execution time is slower.
Time taken **Memory efficiency**	Generates intermediate object code which further requires linking, hence requires more memory.	No intermediate object code is generated, hence are memory efficient.
	Not easy to write	Easy to write
Difficulty level **Debugging**	It generates the error message only after scanning the whole program. Hence debugging is comparatively hard.	Continues translating the program until the first error is met, in which case it stops. Hence debugging is easy.
Programming language	Programming language like C, C++ use compilers.	Programming language like Python, Ruby use interpreters.

4.3 APPLICATION SOFTWARE

Application software products are designed to satisfy a need of a particular environment. All software applications prepared in the computer lab can come under the category of Application software.

Application software may consist of a single program, such as Microsoft's notepad for writing and editing a simple text. It may also consist of a collection of programs, often called a software package, which work together to accomplish a task, such as a spreadsheet package.

✓ Examples of Application software are the following :

- Payroll Software.
- Student Record Software.
- Inventory Management Software.
- Income Tax Software.
- Railways Reservation Software.
- Microsoft Office Suite Software.
- Microsoft Word.
- Microsoft Excel.
- Microsoft PowerPoint.

Different organizations need different application programs specific to their need. The application program may be customized or tailor-made according to their specific purpose. The special purpose programs are also known as "packages". There are general purpose application programs which support generally used information processing instead of specific task.

Application software is a set of one or more programs designed to do a specific task such as processing of student admission examination result, pay calculation, etc.

Some of the general-purpose tools are development tools, that are used to build application programs. The most widely used general-purpose application packages are EXCEL, WORD, ORACLE, DTP packages etc. The general-purpose application for example EXCEL can be used to build decision support applications such as resource allocation, scheduling, inventory control.

similarly, these packages are used for statistical analysis for conducting financial analysis and market research. Thus application programs can be summarized as follows:

(a) Program written by users, for a particular purpose, such as payroll, inventory control, scientific or engineering calculations, etc.

(b) "Packaged" programs written for a wide and restricted purpose, are supplied by vendors for end users. For example: Word processors for creating text documents; Excel or Tally for financial analysis work; database packages for creating maintaining and searching large structured data collections; statistical analysis package (SPSS).

(c) Installation libraries, containing programs of types (a) and (b) and databases that are useful to several users at an enterprise. "Data dictionary" is a complex software used to manage access to these objects.

4.3.1 General Purpose Application Software

General purpose software refers to pre-written software that are designed for a variety of applications and uses. Such as visual Foxpro, Excel, etc.

The packaged software is pre-written software this alternative is least expensive. But drawback of buying a packaged software is that the Software may not be exactly the same as per the requirements of the organisation.

These softwares are not linked to specific business tasks but support the framework for a number of personal, business and scientific applications. Spread sheet, Computer Aided Design (CAD), Word Processing software fall in this category. For example, an accountant can use General purpose software such as EXCEL to create balance sheet of the company. MS Word can be used by general manager to draft a letter. Graphic software CAD/ CAM enables, its uses to create store, edit, view architectural designs. Multimedia Software. Flash/Macro media allows its users to create ani-mated movies with audio and video effects. Some of the General-Purpose Application Software based on personal computers are described in later chapters of this book.

REFERENCE TABLE FOR APPLICATION SOFTWARE

Software	Purpose	Examples
Word processor	To create and edit written documents.	Letters, reports, memos.
Desktop publisher	To create well laid out informative documents of various types using visually appealing graphics and text.	Flyers, brochures, news-letters, business cards, invitations.
Slide show software	To create interactive pre-sentations.	Local tourist guide.
Spreadsheet	To create computer models using primarily data, formulate and rules.	Break even analysis, personal finance, cash flow model.
Database	To create a structural set of data for searching, sorting and producing informative reports.	Student record keeping, stock control, customer records.
Graphic packages	To produce and edit drawings, photos and other images.	To draw pictures for a brochure, to edit a scanned image.
Design Packages (CAD)	To create technical drawings/ design specification.	To design a building or bridge

4.3.2 Tailored Made Software

Often it happens that application/General Software do not meet the requirements of the users or utilities/tools provided in the software are not of any use for a particular job. Thus, a customized Software package can be developed in-house to meet user's requirements. In order to develop tailor made software following steps need to be performed, these are

(i) Identify the user requirements and list them out.

(ii) Analyse the functional modules and decide for in-house development or select a vendor to develop that software that meets the user requirement.

(iii) Process the tailor-made software development in various stages such as coding, testing, debugging, documentation, implementation and training for the planned program.

(iv) Skilled staff needed to repair and maintain the software. If software is developed by outside party. It is easier to carry out changes in the software, if it is developed in house.

Tailor made software is usually developed by in-house programmers. The main advantage of the tailor-made software is that software is designed for the exact needs of the organisation. But developing a software in-house may be very time consuming and expensive proposition.

REVIEW QUESTIONS

1. What do you ean by software ? Explain its different types.
2. How system software is different from Application Software?
3. What are the different types of System Software? Explain.
4. What are the different types of Application Software? Explain.
5. What are language translators? Explain in detail.
6. Differentiate Compiler and Interpreter.
7. Explain the process of language translation.
8. Write short notes on:
   (a) Operating System
   (b) Device Drivers
   (c) System Utilities
   (d) Programming Language
   (e) Compiler
   (f) Assembler
   (g) Linker
   (h) Loader
   (i) Interpreter
   (j) General purpose application software
   (k) Tailor made application software.

5

CHAPTER

Operating System

LEARNING OUTCOMES

- Introduction to Operating system
- Types of Operating system
- Booting Process and Starting sequence
- Important terms - GUI, File, Directory, Volume, Label, Drive and Drive name

5.0 INTRODUCTION TO OPERATING SYSTEM

An **operating system** is the most important software that runs on a computer. It manages the computer's memory and processes, as well as all its software and hardware. It also allows one to communicate with the computer without knowing how to speak the computer's language. Without an operating system, a computer is useless.

The fundamental goal of a Computer System is to execute user programs and to make tasks easier.

Various application programs along with hardware system are used to perform this work. Operating System is a software which manages and control the entire set of resources and effectively utilize every part of a computer.

The figure shows how OS acts as a medium between hardware unit and application programs.

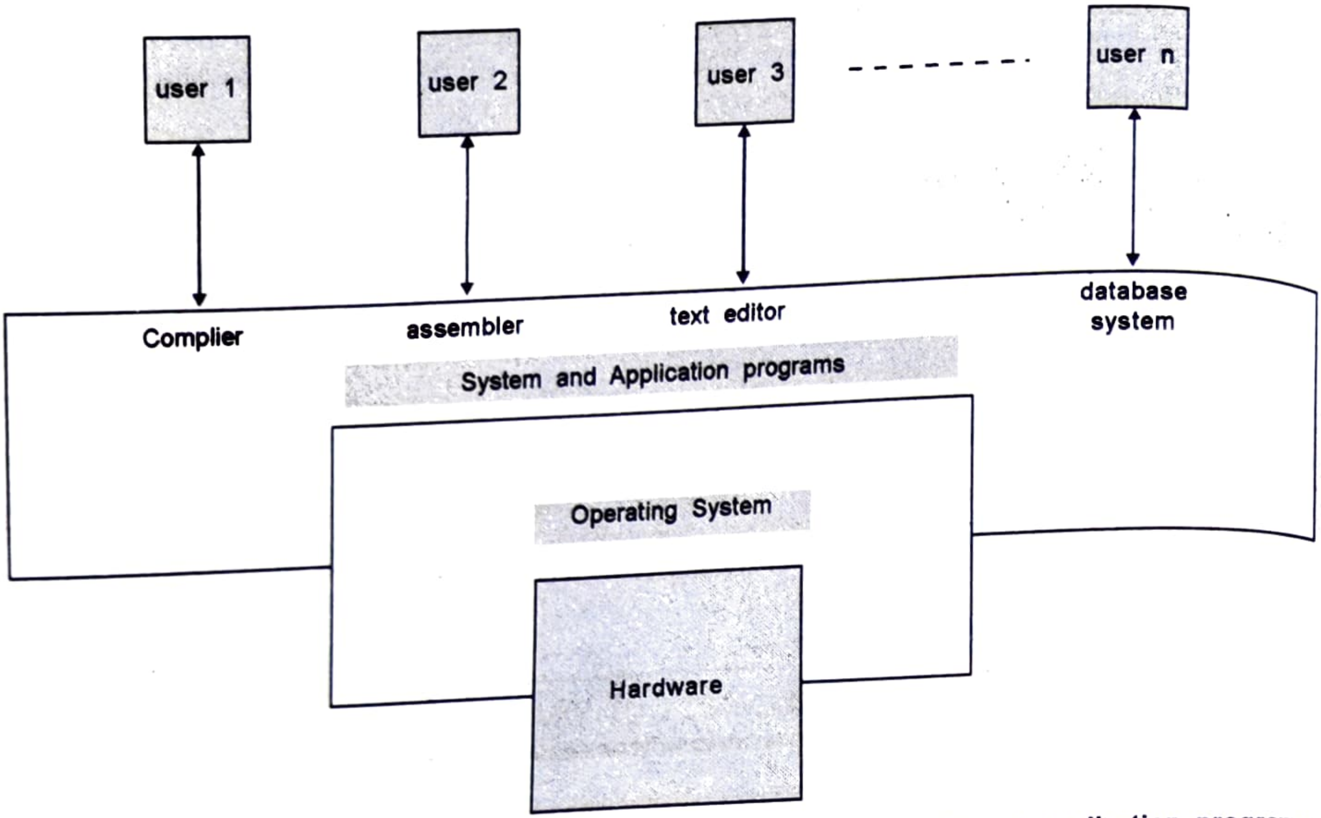


Figure 5.1 Operating system as a medium between hardware unit and application programs.

5.1 CLASSIFICATION OF OPERATING SYSTEM

I. On the basis of use of computers

(a) **Desktop Operating system** : Operating systems that run on desktop computers are the most common. Generally, the operating systems in this category include Windows, Mac OS and DOS. Windows in its many versions (XP and Vista) is currently the leading desktop operating system, running on over 90% of all new systems sold. Mac OS runs on Apple Macintosh and Power PC and was the first widely used operating systems with a graphical interface. DOS was first introduced in 1980 with. IBM's original IBM PC. This rapidly dying 8-bit operating system is at the low end of the scale, with character-based interface, single tasking, etc.

(b) **Server Operating system** : Server Operating Systems Computers in a modern organization's networks are connected to one another not directly but through powerful computers called servers that provide security to the networks and route traffic from one network to another, complicated tasks requiring special operating systems. These powerful 32 or 64-bit operating systems are secure, multitasking, multithreading and open. All have recently had graphical user interfaces developed for them. Some examples of server operating systems are UNIX, Windows Server 2008, eComStation (formerly OS/2), etc.

(c) **Mainframe Operating system** : Mainframe Operating Systems In the days when mainframes and minicomputers dominated the computing world, each computer company developed its own operating system. For example, some IBM mainframe computers use an operating system called OS/z and Digital Equipment Corporation minicomputers use one called OpenVMS. These companies developed not only their own operating systems but also the applications that run on top of them. These are called proprietary systems. Example of mainframe OS also include Multics (Multiplexed Information and Computing Service) which was a mainframe time-sharing operating system that was developed in the 1963-1969 period through the collaboration of the Massachusetts Institute of Technology (MIT), General Electric (GE), and Bell Labs.

II. On the basis of computer's capabilities and features

(a) **Single user Operating system** : As the name implies, this operating system is designed to manage the computer so that one user can effectively do one thing at a time. The Palm OS for Palm handheld computers is a good example of a modern single-user, single-task operating system.

(b) **Single-user, multi-tasking Operating system** : This is the type of operating system most people use on their desktop and laptop computers today. Microsoft's Windows and Apple's MacOS platforms are both examples of operating systems that will let a single user have several programs in operation at the same time. For example, it's entirely possible for a Windows user to be writing a note in a word processor while downloading a file from the Internet while printing the text of an e-mail message.

(c) **Multi-user Operating system** : A multi-user operating system allows many different users to take advantage of the computer's resources simultaneously. Some operating systems permit hundreds or even thousands of concurrent users. The operating system must make sure that the requirements of the various users are balanced, and that each of the programs they are using has sufficient and separate resources so that a problem with one user doesn't affect the entire community of users. Unix, VMS and mainframe operating systems, such as MVS, are examples of multi-user operating systems.

(d) **Multiprocessing Operating System** : Multiprocessing refers to as computer system's ability to support more than one process (program) at the same time. Multiprocessing operating systems enable several programs to run concurrently. Z/OS and UNIX are the two of the most widely used multiprocessing systems, but there are many other, including eComStation for high-end PCs. Multiprocessing systems are much more complicated than single process systems, because the operating system must allocate resources to competing processes in a reasonable manner. Multiprocessing also refers to the utilization of multiple CPUs in the single computer system. This is also called parallel processing.

(e) **Multitasking Operating System** : Multitasking allows more than one program to run concurrently. Multitasking is the ability to more than one task at the same time, a task being a program. The terms multitasking and multiprocessing are often used interchangeably, although multiprocessing sometimes implies that more than one CPU is involved. In multitasking, only one CPU is involved, but it switches from one program to another so quickly that it gives the appearance of executing all of the programs at the same time.

There are two basic types of multitasking :

- **Preemptivemultitasking** : In preemptive multitasking, the operating system parcels out CPU time slices to each program. Example, eComStation, Windows Vista, Windows Server 2008, the Amiga operating system and UNIX use preemptive multitasking
- **Cooperative multitasking** : In this each program can control the CPU for as long as it needs it. If a program not using the CPU, however, it can allow another program to use it temporarily. Example, Microsoft Windows Vista and the MultiFinder (for Macintosh computers) use cooperative multitasking.

(f) **Multithreading Operating System** : Multithreading allows different parts of a single program to run concurrently. Multithreading is the ability of an operating system to execute different parts of a program, called threads, simultaneously. The programmer must carefully design the program in such a way that all the threads can run at the same time without interfering with each other.

(g) **Real-time Operating System** : Real-time operating systems are systems that respond to input immediately. This category includes operating systems designed substantially for the purpose of controlling and monitoring external activities with timing constraints. They are used for such tasks as navigation, in which the computer must react to a steady flow of new information without interruption. Most general-purpose operate systems like DOS and UNIX are not real-time because they can take a few seconds, or even minutes, react. Some examples of real-time operating systems are:

- Basic Real-time Monitor (Real-time OS for the Phillips P-855 and P-860)
- BLMX (Board-level multitasking executive for National Semiconductor 8080 and Z-80 ha' CPU boards)
- CTOS (Real-time, multitasking, multiprocessing OS for 8086 family)

5.2 FUNCTIONS OF AN OPERATING SYSTEM

The main functions of an OS are explained under different headings for easy understanding,

5.2.1 Process Management

The term 'process' was firstly used by Dale 's and Dennis R. in 1960. A process/task is an instance of a program in execution. A program is just a passive entity whereas a process is an active entity. A process performs the required functions of its related program. Please note that a process/ task is the smallest unit of work that is independently schedulable. To accomplish its task, a process needs certain resources like CPU, memory, files and I/O devices. These resources are allocated to the processes by our OS only. Processes solved the problems introduced by-

- Multiprogramming batch operations.
- Time sharing.
- Real-time transaction systems.

✓ OS has following **functions related to theprocess management** :

(a) **Process creation**: It involves loading of the program from secondary storage to the memory and to start its execution.

(b) **Process scheduling**: It means aprocess is transferred from the ready-state to a run-state.

(c) **Process suspending**: It involves transferring a process from run-state to wait-state

(d) **Process Resuming**: It means transferring a process form wait-state to a ready-state when I/O request has been completed or an event occurs.

(e) To provide process **synchronizations for resource sharing** among concurrent processes.

(f) To provide **inter-process communication** among concurrent processes.

(g) **Process termination** is also done by OS only. When a process has finished successfully or when it has committed a fatal error then a process needs termination or deletion. So, now the resources held by the processes are released and process control Block (PCB) is deleted. (Whenever a process is created, its PCB is also created automatically).

5.2.2 Memory Management

Here, memory means the main memory (RAM). For a program to get executed, it must be mapped to absolute addresses and loaded into memory. So, efficient memory utilization is very necessary here. This is done by the OS. The principle storage management, responsibilities are as follows:

(a) **Process isolation** : It means the controlling of one process that interacts with dates and memory of other process.

(b) **Automatic allocation and Management** : Memory should be allocated dynamically based on the priorities of the process. otherwise the process waiting will increase which will decrease CPU and memory utilization.

(c) **Support of modular programming** : Instead of loading, one big monolithic program, we can load only some modules (if our program is modular). This will increase CPU and memory utilization.

(d) **Protection and access control**: Don't apply protection techniques and access control to all the processes. It is better to apply it to important applications only. This will save the execution time.

(e) **Long-term storage**: Long-term storage of a process will reduce the memory utilization. So, swapping-in and swapping-out of the processes is to be done.

5.2.3 I/O Device Management

As it is known that an OS has a set of device drivers i.e., software routines that control respective I/O devices through their controllers. Device drivers are written for Keyboard, Mouse, Monitor, Disk etc. and accordingly these are named as keyboard device driver, mouse device driver and so on. A device driver hides the peculiarities of its I/O device. Also, we know that a device (I/O) communicates with a host CPU through a connection point called as a port. A controller is an electronic device that controls a port or a bus or a device. A controller will have three things:

Processor + Micro-code + Local Memory

Please note that some devices have their own in-built controllers also, like disk drives. The main task of an OS is to collect all the resources (memory, I/O devices) and schedule the resources to the requesting process. This is why an OS is also known as a resource manager. Any resource allocation and scheduling policy must consider three factors:

- **Fairness** : Give equal Priority to the demanding processes at the time of resource scheduling
- **Differential responsiveness** : The OS takes the decisions dynamically based on the classes of jobs and the requirement of jobs.
- **Efficiency** : The main task of an OS is to minimize the waiting time, minimize the response time and to maximize the throughput.

5.2.4 File Management

Information may be stored on Floppies, CDs, hard disk, Tapes etc. OS provides a uniform iogical view of the information storage. This logical storage unit is known as a File. The OS abstracts the logical unit 'File' from of the characteristics underlying media. So, OS is responsible for:

(a) Creation deletion of files.
(b) Creation deletion of directories.
(c) File and directory manipulation.
(d) Backing or storing files onto media like tapes.

5.2.5 Secondary Storage Management

The principle online storage medium for storing programs and data is a disk. Please note that system programs like compilers, debuggers, editors, linkers etc are stored on the disk only and are loaded into the RAM as and when required. Most of the time we are using this hard disk only. It is the job of an OS to swap-out or swap-in such programs. It is our OS that takes care of—

(a) Storage Allocations
(b) Free space Management
(c) Disk Scheduling

5.2.6 Network Management

A distributed OS is an OS that runs on a network of computers. The memory files are shared by the number of users in the network from the server. For example: If 20 nodes are connected by a server through LAN then the OS, files, RAM. processor-slots are all shared by 20 users, from the server. Please note here that each user thinks that he is running on a single large system with one OS. The users of a distributed system need not know where their files are on the network.

5.2.7 System Information Protection

Security System protection refers to the mechanism for controlling the access to computer resources by various users and processes. Since there will be many (multiple) users and hence, multiple process being executed, so there is a need of protection from each other and also protection of OS from the user processes. This is the job of on OS. Generally, three types of protection mechanisms are there-

(a) **Access Control** : It is our OS only that provides read, write or execution access permissions for the files to the users, without these permissions one cannot access the files.

(b) **Information flow Control** : The OS regulates the flow of data within the system. So, some information should be restricted to the users also.

(c) **Certification** : The OS provides the priorities and hierarchies to the resources. So, now we can control unauthorized processes.

5.2.8 System Structure

The size of OS software (code) was quite small in olden days. But now there sizes have gradually increased.

Forexample: The size of WIN -NT OS is 1,60,000 lines of code (LOC) while that of WI 2K is 3,25,00,000 LOC.

Now, it is difficult to manage OS with such a huge code. It is difficult to do addressing, OS may be slow in working and performance is also low.

These problems can be overcome, if the OS code is modular and not monolithic. Thus, organizing, debugging and communications become easy now.

5.2.9 Command Interpretation

It is defined as an interface between the user and the OS. When a new job is started in a batch environment or when a user logs in a time-shared system then the command interpreter is automatically executed. A command interpreter reads and interprets the control statements. it is also known as a shell. There are two ways in which one can interact with OS-

(a) **By means of System Commands**: Users may interact with the OS directly by using OS commands. A command provides an interface between an interactive, user and the OS. For example, if one wish to list files or sub-directories in MS-DOS then invoke dir command.

(b) **By means of System Calls**: System calls provide an interface between the processes and the OS. User Programs receives OS services through a set of system calls only. System calls are usually embedded in the user programs. For example, the use of system calls in C or PASCAL programs resemble very much to our pre-defined function or subroutine calls.

5.3 EXAMPLES OF OPERATING SYSTEMS

Popular OSs for computers are :

- Windows 10
- Mac OS X
- Ubuntu

Popular network/server OSs are :

- Ubuntu Server
- Windows Server
- Red Hat Enterprise

Popular internet/web OSs are :

- Chrome OS
- Club Linux
- Remix OS

Popular mobile OSs are :

- iPhone OS
- Android OS
- Windows Phone OS

5.4 BOOTING PROCESS

Booting (also known as booting up) is the initial set of operations that a computer system performs when electrical power is switched on. The process begins when a computer that has been turned off is re-energized and ends when the computer is ready to perform its normal operations. On modern general-purpose computers, this can take tens of seconds and typically involves performing power-on self-test, locating and initializing peripheral devices, and then finding, loading and starting an operating system. Many computer systems also allow these operations to be initiated by a software command without cycling power, in what is known as a soft reboot, though some of the initial operations might be skipped on a soft reboot. A boot loader is a computer program that loads the main operating system or runtime environment for the computer after completion of self-tests.

The computer term boot is short for bootstrap or bootstrap load and derives from the phrase to pull oneself up by one's bootstraps. The usage calls attention to the paradox that a computer cannot run without first loading software, but some software must run before any software can be loaded. Early computers used a variety of ad-hoc methods to get a fragment of software into memory to solve this problem. The invention of integrated circuit Read-only memory (ROM) of various types solved the paradox by allowing computers to be shipped with a start-up program that could not be erased, but growth in the size of ROM has allowed ever more elaborate start up procedures to be implemented.

There are numerous examples of single and multi-stage boot sequences that begin with the execution of boot program(s) stored in boot ROMs. During the booting process, the binary code of an operating system or runtime environment may be loaded from non-volatile secondary storage (such as a hard disk drive) into volatile, or random-access memory (RAM) and then executed. Some simpler embedded systems do not require a noticeable boot sequence to begin functioning and may simply run operational programs stored in read-only memory (ROM) when turned on.

The order of booting – In order for a computer to successfully boot, its BIOS, operating system and hardware components must all be working properly; failure of any one of these three elements will likely result in a failed boot sequence.

When the computer's power is first turned on, the CPU initializes itself, which is triggered by a series of clock ticks generated by the system clock. Part of the CPU's initialization is to look to the system's ROM BIOS for its first instruction in the startup program. The ROM BIOS stores the first instruction, which is the instruction to run the power-on self test (POST), in a predetermined memory address. POST begins by checking the BIOS chip and then tests CMOS RAM. If the POST does not detect a battery failure, it then continues to initialize the CPU, checking the inventoried hardware devices (such as the video card), secondary storage devices, such as hard drives and floppy drives, ports and other hardware devices, such as the keyboard and mouse, to ensure they are functioning properly.

Once the POST has determined that all components are functioning properly and the CPU has successfully initialized, the BIOS looks for an OS to load.

The BIOS typically looks to the CMOS chip to tell it where to find the OS, and in most PCs, the OS loads from the C drive on the hard drive even though the BIOS has the capability to load the OS from a floppy disk, CD or ZIP drive. The order of drives that the CMOS looks to in order to locate the OS is called the boot sequence, which can be changed by altering the CMOS setup. Looking to the appropriate boot drive, the BIOS will first encounter the boot record, which tells it where to find the beginning of the OS and the subsequent program file that will initialize the OS.

Once the OS initializes, the BIOS copies its files into memory and the OS basically takes over control of the boot process. Now in control, the OS performs another inventory of the system's memory and memory availability (which the BIOS already checked) and loads the device drivers that it needs to control the peripheral devices, such as a printer, scanner, optical drive, mouse and keyboard. This is the final stage in the boot process, after which the user can access the system's applications to perform tasks.

✓ Boot Loader

Computers powered by the central processing unit can only execute code found in the systems memory. Modern operating systems and application program code and data are stored on non-volatile memories or mass storage devices. When a computer is first powered on, it must initially rely only on the code and data stored in non-volatile portions of the systems memory. At boot time, the operating system is not really loaded and the computer's hardware cannot perform many complex systems actions.

The program that starts the "chain reaction" which ends with the entire operating system being loaded is known as the boot loader (or bootstrap loader). The term creatively came from early designers imagining that before a computer "runs" it must have it's "boots strapped". The boot loader's only job is to load other software for the operating system to start. Often, multiple-stage boot loaders are used, in which several small programs of increasing complexity sequentially summon one after the other, until the last of them loads the operating system.

✓ Boot Devices

The boot device is the device from which the operating system is loaded. A modern PC BIOS (Basic Input/Output System) supports booting from various devices. These include the local hard disk drive, optical drive, floppy drive, a network interface card, and a USB device. Typically, the BIOS will allow the user to configure a boot order. If the boot order is set to:

1. CD Drive
2. Hard Disk Drive
3. Network

then the BIOS will try to boot from the CD drive first, and if that fails then it will try to boot from the hard disk drive, and if that fails then it will try to boot from the network, and if that fails then it won't boot at all.

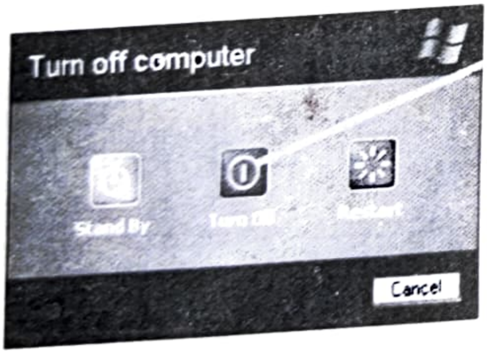
✓ Boot Sequence

There is a standard boot sequence that all personal computers use. First, the CPU runs an instruction in memory for the BIOS. That instruction contains a jump instruction that transfers to the BIOS start-up program. This program runs a poweron self test (POST) to check that devices the computer will rely on are functioning properly. Then, the BIOS goes through the configured boot sequence until it finds a device that is bootable. Once BIOS has found a bootable device, BIOS loads the bootsector and transfers execution to the boot sector. If the boot device is a hard drive, it will be a master boot record (MBR). The MBR code checks the partition table for an active partition. If one is found, the MBR code loads that partition's boot sector and executes it. The boot sector is often operating system specific, however in most operating systems its main function is to load and execute the operating system kernel, which continues start-up. If there is no active partition or the active partition's boot sector is invalid, the MBR may load a secondary boot loader which will select a partition and load its boot sector, which usually loads the corresponding operating system kernel.

✓ Types of Booting

Booting can be done is two ways :

1. **Cold Booting or Soft Booting** : When the power is switched OFF or the computer system OFF or the computer system is shut down and again ON, then cold booting is performed. All steps of booting are performed in this type of booting process.



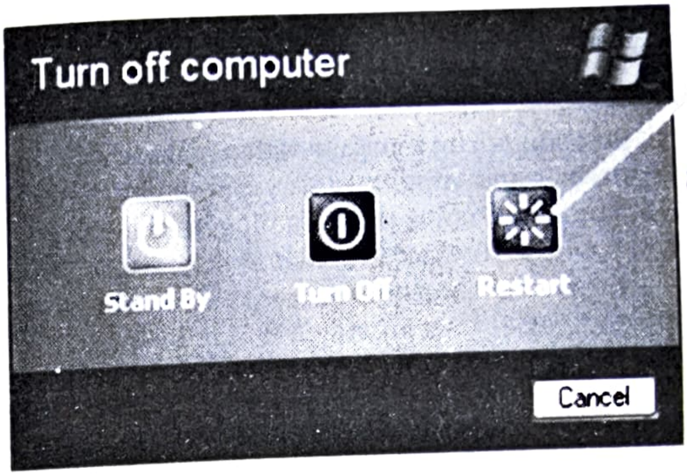
Turn Off

Shuts down Window so that you can safely turn off the computer

OR

ALT +F4

2. **Warm Booting or Hard booting** : When CTRL, ALT and DEL keys are press simultaneously, and then warm booting is performed. The first step of booting process (memory test 0 is skipped, when this booting is applied. Reset button can also be used for this type of booting.



Restart

Shuts down Windows and then strats Window again.

OR

CTR +ALT+DEL PRESS

5.5 STARTING SEQUENCE

Here are the steps :

- The CPU initializes itself after the power in the computer is first turned on. This is done by triggering a series of clock ticks that are generated by the system clock.
- After this, the CPU looks for the system's ROM BIOS to obtain the first instruction in the start-up program. This first instruction is stored in the ROM BIOS and it instructs the system to run POST (Power OnSelf Test) in a memory address that is predetermined.
- POST first checks the BIOS chip and then the CMOS RAM. If there is no battery failure detected by POST, then it continues to initialize the CPU.
- POST also checks the hardware devices, secondary storage devices such as hard drives, ports etc. And other hardware devices such as the mouse and keyboard. This is done to make sure they are working properly.
- After POST makes sure that all the components are working properly, then the BIOS finds an operating system to load.
- In most computer system's, the operating system loads from the C drive onto the hard drive. The CMOS chip typically tells the BIOS where the operating system is found.
- The order of the different drives that CMOS looks at while finding the operating system is known as the boot sequence. This sequence can be changed by changing the CMOS setup.
- After finding the appropriate boot drive, the BIOS first finds the boot record which tells it to find the beginning of the operating system.
- After the initialization of the operating system, the BIOS copies the files into the memory. Then the operating system controls the boot process.

- In the end, the operating system does a final inventory of the system memory and loads the device drivers needed to control the peripheral devices.
- The users can access the system applications to perform various tasks.

5.6 SOME IMPORTANT TERMS

5.6.1 Graphical User Interface

Graphical User Interface or GUI is a kind of an interface which makes use of the computer's graphic abilities to make a program easier and simpler to use. A well-designed GUI can avoid the need for a user to learn a command or complex programming languages. It is a type of an interface which makes it possible for users to interact with electronic devices through graphical icons, as well as visual indicators like secondary notations rather than text-based interfaces. One of the most common examples of a Graphical User interface is Windows from Microsoft.

✓ **The First Graphical User Interface :**

The first ever GUI was designed in the year 1970s by Xerox Corporation's Palo Alto Research Center. But only in the 1980s, on the arrival of Apple Macintosh did the graphical user interfaces become popular.

✓ **Basic components of Graphical User Interfaces :**

The following are the most basic components on which a GUI works:

- o Desktop – this is the area on the display screen where the various icons are grouped together.
- o Windows – the screen can be divided into different parts or areas and in each of these windows, a different program can be run at the same time. The windows can be moved around the display screen, can be adjusted in size and can be minimized as well.
- o Pointer – this is a symbol which can be seen on display screen and is one which is moved to select items and objects. A pointer mostly appears as a small arrow.
- o Pointing device – a pointing device is a device through which the pointer is controlled and is in the form of a trackball or a mouse.
- o Icons – another important component of a graphical user interface is an icon. Small pictures which represent commands, windows or files are known as icons, and one can execute a command by bringing the pointer on top of an icon and then pressing the button on the mouse. The icons are present on the screen and can be moved around as well.
- o Menus – GUIs also consist of another component which is known as menus. Menus bring a list of other icons and commands which further help users to select the action they wish to take.

✓ **Benefits of Graphical User Interfaces :**

A GUI has many benefits, and the following are some of the main ones:

- o Graphical user interfaces make it simpler to transfer information in between different applications besides the benefits of their visual components.

- Unlike a command line operating system like MS-DOS or UNIX, a GUI is much easier to use, learn and customize. It is not important for a person to learn commands in order to use such a system, and almost anyone in the world can use it without troubles.
- Because of their ease to use, GUIs have become the dominant operating system in today's time and age.
- Since the formats in GUIs are so well defined, data can be shared among many different programs which work under a common Graphical User Interface. This means that copying a graph made in a spreadsheet format to a document format is made easy by GUI.

5.6.2 Directory

A directory is defined as an organizational unit, or container, used to organize folders and files into a hierarchical structure. A directory contains bookkeeping information about files that are, figuratively speaking, beneath them in the hierarchy. A directory can be assumed as a file cabinet that contains folders that contain files.

The directory contains information about the files, including attributes, location and ownership. Much of this information, especially that is concerned with storage, is managed by the operating system. The directory is itself a file, accessible by various file management routines.

✓ **Information contained in a device directory are:**

- Name
- Type
- Address
- Current length
- Maximum length
- Date last accessed
- Date last updated
- Owner id
- Protection information

✓ **Operation performed on directory are:**

- Search for a file
- Create a file
- Delete a file
- List a directory
- Rename a file
- Traverse the file system

✓ **Advantages of maintaining directories are:**

- Efficiency : A file can be located more quickly.

- **Naming** : It becomes convenient for users as two users can have same name for different files or may have different name for same file.
- **Grouping** : Logical grouping of files can be done by properties e.g. all java programs, all games etc.

✓ **Example of Directory**

C:\Program Files\Microsoft Office\root.ini

In this example,

C: - drive; root

Program Files – parent directory of Microsoft Office; Sub-directory / Child of C:

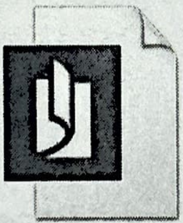
Microsoft Office – current directory; Sub-directory / Child of Program Files

Root – File

.ini – File extension

5.6.3 File

A file is an object on a computer that stores data, information, settings, or commands used with a computer program. In a GUI(graphical user interface), such as Microsoft Windows, files display as icons that relate to the program that opens the file. For example, the picture is an icon associated with Adobe Acrobat PDFfiles. If this file is on the computer, double-clicking the icon in Windows would open that file in Adobe Acrobat or the PDF reader installed on the computer.



Computerapplication.pdf

Creation of Files:A file is created using a software program on the computer. For example, to create a text file use a text editor, to create an image file use an image editor, and to create a document use a word processor.

Storage of Files:Computer files are stored on a drive (e.g., the hard drive), disc, (e.g., DVD), and a diskette (e.g., floppy disk) and may also be contained in a folder (directory) on that medium.

✓ **Types of File Operations** :

- Read Operation : Meant to read the information which is Stored into the Files
- Write Operation : For inserting some new Contents into a File.
- Rename or Change the Name of File.
- Copy the File from one Location to another.

- Sorting or Arrange the Contents of File.
- Move or Cut the File from One Place to Another.
- Delete a File
- Execute means to Run means File Display Output.

✓ File types and their extensions : Various file types and their extensions are as follows :

- Executable - exe, com, bin
- Object - obj, o
- Source Code - C, java, pas, asm, a
- Batch - bat, sh
- Text - txt, doc
- Word Processor - wp, tex, rrf, doc
- Archive - arc, zip, tar
- Multimedia - mpeg, mov, rm

5.6.4 Volume

Volume refers to a tape or disk that stores computer data. Sometimes large hard disks are divided into several volumes (called Partitions), each of which is treated as separate disk. In computers, a volume is an identifiable unit of data storage that is sometimes (but not always) physically removable from the computer or storage system. In tape storage systems, a volume may be a tape cartridge (or, in older systems, a tape reel). In mainframe storage systems, a volume may be a removable hard disk. Each volume has a system-unique name or number that allows it to be specified by a user.

5.6.5 Volume label

Volume label refers to a name for disk or tape. For mass storage devices, a label is the name of a storage volume. It is sometimes referred to as a volume label. An area on tape or disk that is used to identify the tape volume and its owner. In DOS systems, the name of a volume (that is, the name of a disk or tape). Specifying a volume label makes it easier to keep track of what data is stored on each medium. In MS-DOS system, it seldom uses disk names except in directory listing, which use the term value label. Whereas Apple Macintosh systems often refer to disk by name. A volume label is basically a name that is assigned to the drive. For example, C: drivehas a volume label of "All Software", and D: drive has a volume label of "Professional Documents", E: drive as "Entertainment stuff", and so on. This is done so that the names are a reminder of the drive a person is accessing.

5.6.6 Drive and Drive Name

A drive is a location (medium) that is capable of storing and reading information that is not easily removed, like a disk or disc. All drives store files and programs that are used by a computer. For example, when a letter is written in a word processor the program is loaded from hard drive and when the document is saved, it is saved to the hard drive or other disk or drive. The picture is an example of different drives listed in Microsoft Windows My Computer.

In the example (Figure , drive A: is the floppy drive, C: is the primary hard drive, D: and E: are partitions of the hard drive, and F: is the CD-ROM drive. The CD-ROM drive is usually the last drive letter, so in most situations the hard drive is the C: drive and a CD-ROM or other disc drive is the D: drive.

The C drive (C:) is the main hard disk partition which contains the operating system and the related system files. In Windows operating systems, the C drive as represented as "C:\", the backlash representing the root directory of the drive. The C drive is considered as the primary hard drive of the system and is used for storing the operating system, system files and other applications and their related files.

Drive name is a name assigned to a storage unit such as a hard disk, floppy disk or CD ROM when the disk is first formatted or created.

REVIEW QUESTIONS

1. What is Operating System? Explain the various types of Operating System.
2. Explain in detail the functions of an Operating system.
3. What is Booting? Explain the types of Booting?
4. Explain the Booting process in detail.
5. Elucidate the Starting sequence of a computer system in detail.
6. Write notes on:
   (a) Boot loader
   (b) Boot devices
   (c) Boot sequence
   (d) Cold Booting
   (e) Warm Booting
   (f) Graphical User Interface
   (g) File
   (h) Directory
   (i) Volume
   (j) Label
   (k) Drive

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6

CHAPTER

Programming Language

LEARNING OUTCOMES

- ☐ Machine Languages
- ☐ Symbolic/ Assembly Languages
- ☐ High Level Languages
- ☐ Fourth Generation Languages

6.0 MACHINE LANGUAGES

Machine language is the lowest form of computer language. Programs were only written in binary based machine level language in the first-generation computers. The computer understands this language only at its lowest level. An instruction prepared in machine language has two parts:

1. Op-code : This is the first part and is the command or operation which tells the computer what function to perform.
2. Operand : The second part of the instruction is the operand and it tells the computer where to find or store the data or instructions that are to be manipulated. The number of operands in an instruction varies from computer to computer. In a single operand machine, the binary equivalent of "ADD 0184" could cause the value in a storage location 0184 to be added to a value stored in the arithmetic & logic unit. The single operand format is popular in the smallest microcomputers, whereas the two-operand structure is found in most other machines.

The set of instructions in a machine level language can be divided into four categories:

- Arithmetic- add, subtract, multiply and divide.
- Controlled- load, store, jump instructions.

- Input/output- Read and write.
- Direct use- Halt, start and end.

No arithmetic or comparison operations are done in the primary memory of the computer. Instead, it is done in the ALU's special register called accumulator. Thus, if need to add two numbers, we require one instruction which will order the control unit to place a number in the accumulator, and another instruction to identify the operation of addition.

Let us assume that operation codes of 01 to 08 are given for doing 8 basic Let operations of a computer. They are as follows:

To add two numbers, the program of machine language will be as follows :

Location Hex	Instruction Code Binary	Instruction CodeHex	Instruction	Comments
100	0010 0001 0000 0100	2104	LDA 104	Load first operand into AC
101	0001 0001 0000 0101	1105	ADD 105	Add second operand to AC
102	0011 0001 0000 0110	3106	STA 106	Store sum in location 106
103	0111 0000 0000 0001	7001	HLT	Halt computer

(Assuming 2 – LDA, 1 – ADD, 3- STA)

The above example illustrates that in machine language, the programmer has to remember the codes of the instruction and supply the numeric addresses. In addition to the above, he has to keep track of the storage locations of the data and instructions. In machine language the initial coding often took months; it was expensive, prone to errors and error correction was a tedious process.

6.1 SYMBOLIC / ASSEMBLY LANGUAGES

The above-explained process of writing programs was cumbersome. In order to reduce the burden, symbolic language, commonly known as assembly language was developed in the 1950's for second generation computers.

This language permits the use of symbols or mnemonics, which are two or three letter abbreviations, for the function to be performed by the instruction. These are then translated by using a symbolic equivalence table. Assembly language has many of the same features to control registers etc. However, the disadvantage of using binary has been removed. The table below shows some of the mnemonic codes for IBM mainframes.

Mnemonic	Description
ADD	Addition
SUB	Subtraction
MULT	Multiplication
DIV	Division
LDA	Load accumulator with value
STO	Stores contents of accumulator
IN	Read a value into accumulator
OUT	Output value in accumulator to output device
JUM	Jump unconditionally
JGT	Jump to the address portion if the contents of accumulat greater than zero

As is evident, machine language is used by the computer. Therefore, the assembly language software translates the specified operation code into its machine language equivalent before the program can be executed. Here is an example of a symbolic / Assembly Language program to add two numbers:

ORG 100	/Origin of program is location 100
LDA A	/Load operand from location A
ADD B	/Add operation form location B
STA C	/Store sum in location C
HLT	/Halt computer

✓ Advantages of Assembly Languages

- They save time and reduce detail as compared to machine language.
- Lesser number of errors are made, and also errors are easier to detect.
- Assembly programs are easier to modify than machine language programs.

✓ Disadvantages of Assembly Languages

- Writing a code is time-consuming.
- Assembly languages are machine-dependent.

6.2 HIGH LEVEL LANGUAGES

The disadvantages of using assembly language brought about the development of higher-level languages. Unlike the assembly programs, high level language programs may be used with different makes of computers with little modification. High level languages are easier to learn than symbolic languages; they require less time to write, are easier to maintain, provide better documentation, and 4 or 5 low-level instructions are reduced to a single high-level statement. Some of the popular high-level languages are given in the table below.

Language	Meaning
FORTRAN	Formula Translator
COBOL	Common Business
ALGOL	Algorithmic language
RPG	Report Generator
APL	A Programming Language
PL/1	Programming Language 1
BASIC	Beginners AIL-purpose Code
PASCAL	Named after the French Philosopher

6.2.1 Classification of High-Level Languages

High level languages are sometimes classified as :

- ✓ **Procedure Oriented Languages** : Procedure oriented languages provides easy to use features which allow the programmer to write processing steps required for a particular application. Examples of procedure-oriented languages are COBOL, FORTRAN, PL/1 etc.
- ✓ **Problem Oriented Languages** : These languages attempt to solve processing requirements with minimal programming effort; thereby, allowing the user to concentrate on the desired results, rather than on the individual steps needed to get these results. A typical example of a problem-oriented language is RPG.
- ✓ **Interactive Programming Languages** : These languages have features which allow the user to interact with the program in a conversational fashion. A typical example is BASIC language.

6.3 FOURTH GENERATION LANGUAGES

Computer people refer to the machine language era as the first generation, the symbolic codes one as the second generation, and the advent of the high-level languages as the third generation. Successive generations of languages brought about an increase in the programmers' productivity. These generations of software have now been followed by the emergence of software vendors, offering a variety of application development tools, aimed at further productivity improvement. These tools are collectively known as 4th Generation Languages (4GLs).

Essentially, a 4GL tool interacts with a DBMS (Database Management System) software to store, manipulate and retrieve the data required to satisfy requirement. In contrast to a high-level language, which is procedural, a 4 GL is a non-procedural language, in the sense that it allows the user to simply specify what the output should be, without describing all the details of how data is to be manipulated to get the results.

A clear-cut definition of a 4GL is not possible, because each tool or language is vendor specific. In general, however, we have the following classification :

- **End user oriented 4GLs** : These are designed for applications that process low data volumes and run on mainframes and may be used by users or programmers. They have their own internal data base management software, which in turn interacts with the organization's DBMS. Non-computer professionals use these products to query databases and develop their own applications and generate reports with minimum training.
- These tools are offered by the same suppliers who also supply the complex DBMS packages to the organization. These tools offer a larger set of commands than the end user 4GLs. They are also able to handle larger volumes of data and are generally u by programming specialists. These include query languages, application generators and report generators.

The following chart depicts some of the major differences between higher level languages and 4GLs :

Third Generation Languages	Fourth Generation Languages
Used by professional programmers	May be used by non-programmers also
Require task performance specification (how)	Require specification of what task to perform (what)
All alternatives are specified	Default alternatives are built in
Require large no. of instructions	Require far fewer instructions
Code difficult to read, understand	Code easy to read and maintain
Originally developed for batch	Developed primarily for online
Can be difficult to learn	Easy to learn
Difficult to debug	Errors easier to locate because of shorter programs and use of defaults
	Typically, database oriented